# Common Interventional Pain Procedures

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COMMON INTERVENTIONAL PAIN PROCEDURES

A range of interventional procedures for pain can be useful in patients with chronic pain who have not achieved adequate relief with conservative treatments. Typically, given the invasive nature of these procedures, they are not first-line treatments for pain. Instead, they are considered only after failure to achieve pain relief with adequate trials of medication, at least 6 weeks of physical therapy, or both.

More than 200 interventional procedures are routinely performed, most often by clinicians who have received additional fellowship-level training. The types of procedures range from simple peripheral nerve blocks to spinal interventions to more-invasive surgical procedures that involve implantation of devices. In each subsection below, the most common interventions are outlined.

PAIN INTERVENTION FUNDAMENTALS

Most interventional pain procedures do not require intravenous access unless the patient has a known history of vasovagal syncope; nor do they require sedation unless the patient is very anxious. Most interventional procedures for pain involve injecting a local anesthetic, such as lidocaine or bupivacaine, combined with a glucocorticoid, such as methylprednisolone or dexamethasone. The local anesthetic provides rapid pain relief; the addition of a glucocorticoid enhances longer-term therapeutic efficacy, given the antiinflammatory property of glucocorticoids.

Injection of a local anesthetic alone can be done, typically when the sole goal of the procedure is temporary reduction of pain conduction. This may be the case in a diagnostic block, performed to confirm the analgesic benefit before implementation of more-invasive interventions such as radiofrequency ablation. Another use of local anesthetic alone is in patients for whom glucocorticoids are relatively contraindicated; some studies have shown, in certain pain conditions such as lumbar stenosis, equal efficacy with local anesthetic alone, compared to a local anesthetic combined with glucocorticoids.

Another broad category of interventional pain procedures are ablation procedures, whereby the conduction of pain signals is interrupted through destruction of the nerves, typically
using thermal or chemical ablation. These procedures provide longer-term benefit but are more invasive than injections of a local anesthetic with or without a glucocorticoid.

**Complications of interventional pain procedures.** Complications are rare and are discussed below with each procedure, but some general considerations are worth highlighting:

- Infection is sufficiently rare that prophylactic antibiotics are rarely used.
- Adverse effects of local anesthetics are usually temporary and include dizziness, headaches, blurred vision, muscle twitching, and localized numbness, tingling, or weakness. An allergic reaction to the local anesthetic or a serious adverse effect such as a seizure or cardiac arrest is very rare.
- If a glucocorticoid is used, the patient is at risk for systemic glucocorticoid exposure with resulting adverse effects (e.g., hyperglycemia, suppression of the hypothalamic–pituitary–adrenal axis, and cushingoid features), especially with repeated injections.
- Vessel occlusion with resulting ischemia also can occur in the case of inadvertent intravascular injection, especially with particulate glucocorticoid solutions such as methylprednisolone or triamcinolone.

**Contraindications to interventional pain procedures.** Contraindications are common among most of the interventions outlined below. They include:

- Active systemic infection or infection of the skin overlying the area where the needle will enter
- Anticoagulation or problems with coagulation. This is especially important with neuraxial procedures, as hemorrhage can lead to irreversible neurologic damage. It is of less concern with peripheral or joint injections (including facet joint injections of the spine), as the risk for nerve compression is low. Anticoagulants should be stopped for a period of time before the procedure, sufficiently adequate to reverse the anticoagulant state. This step is necessary for most anticoagulants, including direct oral anticoagulants and warfarin. For patients taking warfarin, INR should be measured on the day of the procedure. Antiplatelet agents such as P2Y12 inhibitors (e.g., clopidogrel, prasugrel, ticagrelor) are also stopped before these procedures. Low-dose aspirin and nonsteroidal antiinflammatory drugs carry a low risk for bleeding and typically do not need to be stopped before these procedures.
- Hypersensitivity to glucocorticoids, contrast dye, or anesthetic medications
- Local malignancy at the site of injection
- Special considerations should be made in patients with uncontrolled diabetes (injection with local anesthetic alone may be considered), heart failure, pregnancy (fluoroscopy is contraindicated but ultrasound guidance can be used) — and in patients with cardiac device implantation, in cases of radiofrequency ablation (defibrillator may need to be turned off during the ablation process).
Nearly every adult experiences back pain at some point during their lives, but most episodes resolve spontaneously. In approximately 10% of people, pain persists despite conservative measures and results in significant individual disability and societal cost; within this subgroup, interventional therapies can be considered as treatments for both axial and radicular back pain.

Glucocorticoid injections (first described in 1953 and commonly referred to as epidural steroid injections) are the first-line invasive procedure for treating spine-generated pain. Despite widespread use of these injections, controversy remains about their efficacy and uncertainty remains about the mechanism of therapeutic benefit. Several mechanisms have been proposed, including antiinflammatory effects, direct neural membrane stabilization effects, and modulation of peripheral nociceptor input. The vast majority of patients who respond favorably do so within 6 days of injection.

A lumbar MRI is strongly recommended before these neuraxial procedures, to help determine the point of interest for the injection and to rule out conditions that are considered to be contraindications, such as diskitis or epidural fluid collections. The desired site of injection is also determined through physical examination (to identify dermatomal distribution) and, occasionally, neurophysiological studies. Injection of contrast medium is strongly recommended to confirm correct needle placement.

In addition to various approaches for performing epidural glucocorticoid injections, there are other interventional procedures that are used in the management of back pain. The patient's history, physical examination, and MRI findings — as well as the expertise and experience of the clinician performing the procedure — all help to determine the best procedure for any given scenario.
**Indications**

- Lumbar/cervical radiculopathy
- Lumbar/cervical stenosis
- Lumbar/cervical disk herniation without myelopathy

**Potential Complications**

- Epidural bleeding or hematoma
- Local infection, including epidural abscess, which can compress nerve roots or the spinal cord and lead to a radiculopathy or myelopathy
- Direct spinal cord trauma
- Dural puncture, leading to injection of medications into the subarachnoid space with adverse effects such as high spinal anesthesia and respiratory depression

**Clinical Pearls**

- Prepare the patient that they may receive one injection or a series of three injections (typically 4 weeks apart), depending on their response
- Limit injections to 4 to 6 per year, typically 3 months apart after the first series
- Commonly used glucocorticoids are methylprednisolone or dexamethasone

**How to Perform**

- A small needle is placed into the epidural space through the midline under fluoroscopic guidance
- Once the needle is in position, 3 to 5 cc of the injectate is administered slowly, to prevent acute compression of the nerves or spinal cord.

**References:**

# Transforaminal Epidural Glucocorticoid Injection (Lumbar)

## Indications
- Lumbar radiculopathy
- Lumbar stenosis
- Lumbar disk herniation without myelopathy

## Potential Complications
- Epidural bleeding or hematoma
- Local infection, including epidural abscess, which can compress nerve roots or the spinal cord and lead to a radiculopathy or myelopathy
- Direct spinal cord or nerve trauma
- Dural puncture, leading to injection of medications into the subarachnoid space with adverse effects such as high spinal anesthesia and respiratory depression

## Clinical Pearls
- Dexamethasone is commonly used, given reports of catastrophic neurologic injury with particulate glucocorticoid solutions.
- In unilateral radiculopathy, the transforaminal or interlaminar approaches are equally effective in reducing pain and improving function; the choice usually depends on clinician preference and experience.
- In bilateral radiculopathy, the interlaminar approach is preferable, as a single injection can affect both sides, while transforaminal injections would need to be done on both sides.

## How to Perform
- A small needle is placed into the epidural space lateral to the midline (allowing some of the injectate to spread along the nerve, thereby providing a selective nerve block at the same time). Fluoroscopic guidance is used.
- Once the position is confirmed, 1 to 2 mL of the injectate is administered slowly, to prevent nerve compression.

### References:
## Facet Injection/ Medial Branch Block (Cervical, Thoracic, or Lumbar)

### INDICATIONS
- Spondylosis
- Facet arthropathy
- Postlaminectomy syndrome
- Disk degeneration

### POTENTIAL COMPLICATIONS
- Epidural bleeding or hematoma
- Local infection, including epidural abscess, which can compress nerve roots or the spinal cord and lead to a radiculopathy or myelopathy.
- Direct spinal cord or nerve trauma
- Dural puncture, leading to injection of medications into the subarachnoid space with adverse effects such as high spinal anesthesia and respiratory depression

### CLINICAL PEARLS
- The triad of axial neck pain, muscle spasms, and posterior headaches often points to cervical facet arthropathy.
- Diagnostic medial branch blocks to determine candidacy for radiofrequency ablation should use low volumes, to reduce confounding spread to adjacent structures.
- Glucocorticoids are typically used in the injectate to prolong pain relief. However, diagnostic blocks prior to radiofrequency ablation are done with a local anesthetic.
- Some patients elect to get therapeutic medial branch blocks every 3 months rather than proceed to radiofrequency ablation.

### HOW TO PERFORM
- A spinal needle is placed into the area of the facet joints or the medial branch nerves, under fluoroscopic guidance.
- Once in position, 0.5 to 1.0 mL of the injectate is administered at the target site.
- For a detailed overview of this procedure, including videos, see https://www.nejm.org/doi/full/10.1056/NEJMvcm2211108.

### References:
Radiofrequency Lesioning/Neurotomy (Lumbar/Cervical)

**INDICATIONS**
- Significant pain relief (>50%) after diagnostic medial branch blocks

**POTENTIAL COMPLICATIONS**
- Postprocedural pain
- Cutaneous numbness
- Dysesthesias
- Dizziness and ataxia (with cervical radiofrequency lesioning)
- Infection
- Nerve or vascular Injury (rare)

**CLINICAL PEARLS**
- Prior to ablation, perform at least 2 rounds of medial branch blocks to determine the likelihood of response to ablation.
- The average duration of >50% pain relief for radiofrequency neurotomy is 6 to 12 months.

**HOW TO PERFORM**
- A 22-g or 18-g radiofrequency needle is placed into the area of the facet joints along the medial branches under fluoroscopic guidance.
- Sensory and motor stimulation are usually performed before denervation, to ensure proper positioning of the needles close to the target areas and away from the motor fibers.
- A small amount of local anesthetic (typically lidocaine 2%) is injected first. Denervation is then achieved using radiofrequency thermal ablation.

**References:**
### Sacroiliac Joint Injection

**Indications**
- Sacroiliac (SI) joint pain
- SI joint inflammation
- SI joint dysfunction

**Potential Complications**
- Bleeding
- Infection
- Nerve injury
- Transient increased postprocedural pain

**Clinical Pearls**
- Diagnostic analgesic blocks in patients with suspected SI joint pain can provide valuable information about pathologies of joint origin, but pain secondary to pathologies in structures around the SI joint can be missed and are best diagnosed with provocation tests.
- A multitest regimen of 3 or more positive SI joint pain provocation tests (distraction, compression, Gaenslen, Patrick, and thigh thrust tests) is a reliable method for assessing SI joint disease.
- Radiofrequency ablation of the SI joint can be considered for patients who receive only temporary relief from diagnostic SI joint injections.

**How to Perform**
- A spinal needle is placed along and/or into the sacroiliac joint under fluoroscopic guidance.
- Once correct positioning is confirmed with fluoroscopy, the injectate is administered along or into the SI joint.

**References:**
Sympathetic nerve blocks are effective for treating painful conditions that are thought to be mediated by the sympathetic nervous system. The most common indications for the procedure are complex regional pain syndrome (CRPS) and visceral pain (especially visceral pain associated with cancer). Depending on the pain’s location, the sympathetic nerves can be blocked at the stellate ganglion for upper-extremity pain, the lumbar sympathetic ganglion for lower-extremity pain, or the abdomen (celiac, superior, and ganglion impar) for visceral pain.
# Stellate Ganglion Block

## Location of needle entry for a stellate ganglion block

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<th>POTENTIAL COMPLICATIONS</th>
<th>CLINICAL PEARLS</th>
<th>HOW TO PERFORM</th>
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<tr>
<td>Sympathetically mediated painful conditions:</td>
<td>Vascular injury or hematoma:</td>
<td>Although it is considered a side effect, the presence of Horner syndrome is a sign of successful block.</td>
<td>A needle is placed along the stellate ganglion. Positioning can be guided by anatomic landmarks, fluoroscopy, or ultrasound (most common); a combination of fluoroscopy and ultrasound is sometimes used to increase safety and avoid vascular structures.</td>
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<tr>
<td>Complex regional pain syndrome (CRPS) type 1 and 2 of the upper extremity</td>
<td>Carotid artery, internal jugular vein, inferior thyroid artery</td>
<td>Other possible side effects of this block include hoarseness of voice, phrenic nerve block resulting in ipsilateral diaphragmatic paralysis, and brachial plexus block resulting in arm weakness. However, all of these side effects are transient.</td>
<td>A small amount of contrast may be used if fluoroscopy is utilized to confirm positioning and to ensure there is no vascular uptake.</td>
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<tr>
<td>Herpes zoster</td>
<td>Ascending cervical artery</td>
<td>In CRPS of the upper extremity, if stellate ganglion block provides good but short-term relief, neuromodulation is a reasonable next option to consider.</td>
<td>Once correct positioning is confirmed, 5 to 10 mL of the injectate is administered slowly, in small increments, to ensure there is no systemic spread of the injectate.</td>
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<td>Postherpetic neuralgia</td>
<td>Retropharyngeal hematoma</td>
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<td>Peripheral nerve lesions</td>
<td>Neurological injury:</td>
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<td>Phantom limb pain</td>
<td>Vagus nerve, brachial plexus root (C6, C7) injury</td>
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<td>Postmyocardial, sympathetically mediated pain</td>
<td>Locked-in syndrome, stroke</td>
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<td>Malignant, sympathetically mediated pain</td>
<td>Neuraxial injection</td>
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<td>Vascular conditions:</td>
<td>Others:</td>
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<td>Refractory angina</td>
<td>Pneumothorax, chylothorax</td>
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<td>Raynaud disease</td>
<td>Infection</td>
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<td>Peripheral vascular disease</td>
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<td>Long COVID syndrome</td>
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**References:**
SYMPATHETIC NERVE BLOCKS

Celiac Plexus Block (With or Without Neurolysis)

INDICATIONS
- Acute or chronic abdominal pain due to pancreatitis or pancreatic, gastric, esophageal, or biliary malignancies.
- Pain related to mesenteric vascular occlusive disease
- Acute pain after liver embolization

POTENTIAL COMPLICATIONS
- Orthostatic hypotension
- Diarrhea
- Backache
- Uncommon: retroperitoneal hemorrhage, paraplegia, transient cord damage, sexual dysfunction related to sympathetic chain neurolysis, and fistula formation

CLINICAL PEARLS
- Celiac plexus block can be done with local anesthetic and glucocorticoids, or a neurolytic agent such as alcohol or phenol, for prolonged relief (3 months or more).
- In patients with cancer pain, there is an increased tendency to proceed with neurolysis from the start, given the high efficacy of the blocks and to avoid repeated procedures and delayed pain relief.

HOW TO PERFORM
- A 5- or 7-inch spinal needle is placed along the celiac plexus (at the level of the L1 vertebra) under fluoroscopic guidance. The celiac plexus is at the level of the L1 vertebra and can be approached in several manners, but transcrural or retrocrural approaches are used most often. A small amount of contrast is commonly used to confirm needle positioning and lack of vascular uptake.
- After correct needle placement is confirmed, a local anesthetic (bupivacaine and/or lidocaine) is injected with or without a glucocorticoid (methylprednisolone). If the initial test dose relieves the pain, neurolysis can be performed using 50% to 95% alcohol (10–20 mL on each side) or 5% to 10% phenol (10–15 mL on each side).

References:
## Lumbar Sympathetic Block

### Indications
- Complex regional pain syndrome (CRPS) and other sympathetically mediated neuropathic pain phenomena affecting the lower limb
- Early postherpetic neuralgia
- Early phantom limb pain
- Vascular insufficiency affecting the lower extremities

### Potential Complications
- Postprocedural back pain
- Bleeding
- Infection
- Intravascular injection of medication
- Local anesthetic systemic toxicity, if iatrogenic overdose combined with intravascular injection
- Disk puncture and possible diskitis
- Genitofemoral neuritis
- Renal or ureter puncture
- Transient neural blockade from posterior spread of local anesthetic to epidural or subarachnoid spaces (rare)
- Retrograde ejaculation if bilateral sympathectomy is performed

### Clinical Pearls
- A one-needle technique (approaching from one side only) at L2 or L3 is usually used. However, if contrast spread to both sides is not observed, a 2-needle approach (repeating the procedure on the contralateral side) is used at L2 and L4 concurrently.
- If block provides good but short-term relief, neurolysis with phenol or alcohol can be used as a next step.
- In CRPS, lumbar sympathetic block should be combined with alternative treatments, including extensive physical therapy (as desensitization therapy) to provide best results.

### How to Perform
- A 5- to 7-inch bent-tip spinal needle is placed along the sympathetic chain at the level of the L2 or L3 vertebral body, under fluoroscopic guidance. A small amount of contrast is commonly used to confirm needle positioning.
- A skin-temperature probe is usually placed distally on the affected side; an increase in skin temperature of at least 2°C is used to confirm good blockade.
- Intravenous access is needed in case of an adverse event and for moderate sedation if needed.

### References:
Nerve blocks of the head and neck can be used for regional anesthesia and postoperative pain control, as well as for diagnostic and therapeutic purposes in managing conditions that cause chronic headaches. In the algorithm for treating chronic pain, the blocks are indicated when pharmacologic therapy is partially effective or ineffective in alleviating the patient’s pain. Detailed knowledge of the relevant anatomy and of the use of fluoroscopy and ultrasound improves efficacy and minimizes complications.
# Occipital Nerve Block

**INDICATIONS**
- Occipital neuralgia
- Cluster headache
- Cervicogenic headache
- Migraine
- As an adjuvant to medication-overuse headache

**POTENTIAL COMPLICATIONS**
- Infection
- Vasovagal reaction or syncope
- Small area of alopecia with cutaneous atrophy at glucocorticoid injection sites
- Puncture of occipital artery resulting in hematoma
- Peripheral facial nerve palsy

**CLINICAL PEARLS**
- In patients with occipital neuralgia and clear but short-lasting response to greater occipital nerve blocks (ONBs), longer-term relief options include botulinum toxin injection, occipital nerve subcutaneous neurostimulation, and occipital nerve radiofrequency ablation.
- Response to ONB in patients with chronic migraine and chronic cluster headache does not reliably predict occipital nerve stimulator response.

**HOW TO PERFORM**
- A small needle is placed along the greater occipital nerve while the patient is seated.
- No imaging is typically required. However, given tremendous anatomic variability of the greater occipital nerve, ultrasound or electric nerve stimulation may be utilized.
- The lesser occipital nerve (located around two-thirds of the way between the occipital protuberance and the mastoid process) may also be blocked.

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**References:**
Trigeminal Nerve Block

Needle direction for trigeminal nerve block

continued on next page ↓
### Trigeminal Nerve Block

#### INDICATIONS
- Trigeminal neuralgia
- Palliation of cancer pain in head and neck
- Acute herpes zoster
- Postherpetic neuralgia
- Acute facial pain emergencies

#### POTENTIAL COMPLICATIONS
- Dysesthesias
- Anesthesia dolorosa
- Weakness of the muscles of mastication
- Facial hematoma
- Secondary facial asymmetry
- Meningitis
- Intracranial hemorrhage with inadvertent intracranial needle placement
- Total spinal anesthesia

#### CLINICAL PEARLS
- Interventional pain procedures are usually considered only after failure of more-conservative interventions. As trigeminal nerve block is a particularly complex procedure with a higher risk for complications, reserving its use to cases where conservative interventions have failed to adequately control pain is particularly important.

- Trigeminal nerve block may be a useful tool for treating acute exacerbations of trigeminal neuralgia, rather than chronic management. For longer-term relief, radiofrequency ablation or neuromodulation may be a viable option.

#### HOW TO PERFORM
- A 2.5- to 3.5-inch spinal needle is placed near the trigeminal nerve under fluoroscopic guidance. A small amount of contrast is commonly used to confirm needle positioning.

The injectate is a combination of a local anesthetic (lidocaine or bupivacaine) and a glucocorticoid (typically dexamethasone). If chemical neurolysis is considered, a neurolytic agent such as phenol, alcohol, or glycerol may be used.

### References:
Peripheral nerve blocks are commonly used for perioperative and chronic pain management. Almost any peripheral nerve can be blocked, if needed, guided by ultrasound or fluoroscopy. Peripheral nerve blocks are used for both diagnostic and therapeutic purposes.
## Ilioinguinal Nerve Block

<table>
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<th>CLINICAL PEARLS</th>
<th>HOW TO PERFORM</th>
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</thead>
<tbody>
<tr>
<td>Pain in the inguinal region, most commonly postoperative neuralgia after herniorrhaphy or lower abdominal surgery in the region of the ilioinguinal nerve</td>
<td>Inadvertent bowel perforation</td>
<td>The procedure is typically done under ultrasound guidance, but it may be performed by anatomical landmarks. In this case, a large volume of injectate is recommended to ensure proper blockade.</td>
<td>A small needle is placed along the ilioinguinal nerve under ultrasound guidance.</td>
</tr>
<tr>
<td>Inadvertent bowel perforation</td>
<td>Infection</td>
<td>Nerve block offers a prognosis for the effectiveness of neuroablative or neurolytic therapies for longer-term relief.</td>
<td>Once the needle is in position, 5 to 10 mL of the injectate is administered along the nerve.</td>
</tr>
<tr>
<td>Bleeding or hematoma</td>
<td>Postprocedural pain and paresthesia</td>
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<tr>
<td>Nerve injury</td>
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**Location of needle entry for ilioinguinal nerve block**

- **Anterior superior iliac spine**

**Reference:**
**INDICATIONS**

- Useful in diagnosing and treating the entrapment neuropathy of the lateral femoral cutaneous nerve (LFCN), known as meralgia paresthetica
- Can be used for surgical anesthesia and/or postoperative pain control for procedures on the anterolateral thigh, such as skin graft harvesting

**POTENTIAL COMPLICATIONS**

- Bleeding or ecchymosis
- Concomitant femoral nerve blockade
- Trauma to the LFCN or femoral nerve

**CLINICAL PEARLS**

- The procedure is typically done under ultrasound guidance. Undergoing the procedure by only anatomic landmark is not recommended given the highly variable anatomic course of the LFCN.
- Given the superior efficacy of the ultrasound-guided LFCN block, if a patient with symptoms consistent with meralgia paresthetica does not respond to blockade of the nerve, lesions in the lumbar plexus or L2–3 radiculopathy should be considered.

**HOW TO PERFORM**

- With the patient supine, a small needle is placed along the LFCN using either anatomical landmarks or (highly recommended) under ultrasound guidance.
- Once correct positioning of the needle is confirmed, 5 to 10 mL of the injectate is administered.

References:

### Pudendal Nerve Block

#### Landmarks to identify the course of the pudendal nerve

- Sacrospinous ligament
- Sacrotuberous ligament
- Ischiofemoral ligament
- Neck of femur
- Pudendal nerve

#### INDICATIONS

<table>
<thead>
<tr>
<th>Pudendal neuralgia:</th>
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<tbody>
<tr>
<td>- Diagnostically (a positive response is part of the diagnostic Nantes criteria)</td>
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<tr>
<td>- Therapeutically, to provide analgesia</td>
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#### POTENTIAL COMPLICATIONS

- Intravascular injection of medication
- Sciatic nerve injury
- Hematoma
- Perforated rectum (infection, fistula)

#### CLINICAL PEARLS

- The five essential diagnostic criteria for pudendal neuralgia by pudendal nerve entrapment (Nantes criteria):
  1. Pain in the anatomical territory of the pudendal nerve
  2. Worsened by sitting
  3. The pain does not awaken the patient at night
  4. No objective sensory loss on clinical examination
  5. Positive anesthetic pudendal nerve block (pain relief with this procedure)

#### HOW TO PERFORM

- Pudendal nerve block can be attained by a transvaginal or a transrectal approach (landmark technique), a fluoroscopy- or ultrasound-guided transgluteal approach, or as a fluoroscopy-guided transsacral S2–S4 block.

  - With fluoroscopy guidance, a small amount of contrast is commonly used to confirm needle positioning; then 3 to 5 mL of the injectate is administered slowly along the nerve.

#### References:

Genicular Nerve Block
## Genicular Nerve Block

### INDICATIONS

Genicular nerve block can be an option to treat chronic knee pain caused by:

- Osteoarthritis of the knee
- Persistent knee pain after surgery, such as arthroscopy or partial or total knee replacement

Nerve block is typically considered when conservative measures (e.g., physical therapy, acetaminophen, or nonsteroidal anti-inflammatory drugs) or intra-articular treatments (e.g., glucocorticoid injections or viscosupplementation) are either ineffective or contraindicated.

Genicular nerve block is also useful in patients with chronic pain from knee osteoarthritis who are not candidates for knee replacement (for example, because of other medical comorbidities).

### POTENTIAL COMPLICATIONS

- Infection
- Bleeding or hematoma
- Postprocedural pain and paresthesia
- Intravascular injection of the medication

### CLINICAL PEARLS

The knee is innervated by several genicular nerves, but the three primary nerves that run along the bones provide targets for fluoroscopy and ultrasound:

- Superior lateral (SL) nerve (along the femur)
- Superior medial (SM) nerve (along the femur)
- Inferior medial (IM) nerve (along the tibia)

The inferolateral genicular nerve is spared, especially if denervation is planned, because of its proximity to the common peroneal nerve (CPN) to avoid unintended CPN block and foot drop.

Genicular nerve blocks can be diagnostic or therapeutic. A diagnostic block helps to determine if the knee is the source of pain. A single block, or two blocks as part of a double comparative set of diagnostic blocks, might help determine whether radiofrequency ablation of the genicular nerves should be performed.

### HOW TO PERFORM

- The procedure can be done under fluoroscopic guidance (most common) or ultrasound guidance. The genicular nerves are small and cannot be visualized by ultrasound, but landmarks can be used.
- Under fluoroscopic guidance, the target areas along the femur and tibia are identified in AP position; a lateral view is then used before needle insertion.
- Usually, the target areas are superficial enough that a 1.5-inch hypodermic needle can be used. If that is not long enough, then 1% lidocaine can be injected while the needle is pulled out, and a longer 2.5- or 3.5-inch Quincke needle can be reinserted to reach the target nerves.
- For a diagnostic block, only a long-acting anesthetic, such as bupivacaine, can be used. For therapeutic blocks, a glucocorticoid can be added. Only 1 mL of injectate is needed at each target area.

### References:

Dry Needling and Trigger Point Injections

**Trigger points** refer to taut bands of skeletal muscle that can cause point tenderness or referred pain and, sometimes, twitching of the muscle when it is compressed. Risk factors for development of myofascial pain include acute trauma or repetitive microtrauma, overextension of a muscle, poor posture, or sports or occupational injuries. Insertion of a needle (dry needling) or injection of local anesthetic (trigger point injections) into the trigger points can be used to help relieve this pain.

<table>
<thead>
<tr>
<th>INDICATIONS</th>
<th>POTENTIAL COMPLICATIONS</th>
<th>CLINICAL PEARLS</th>
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<tbody>
<tr>
<td>Pain secondary to the presence of myofascial trigger points</td>
<td>Increased pain</td>
<td>Myofascial trigger points are identified by palpation causing localized pain, referred pain, or a local twitch response. These trigger points are often seen or palpated as “bands” or “knots” of muscle.</td>
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<td></td>
<td>Nerve damage</td>
<td>Myofascial pain syndrome is diagnosed clinically through history and physical examination, though new techniques such as pressure algometry and ultrasound can be utilized.</td>
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<td></td>
<td>Infection</td>
<td>Anticoagulants do not need to be stopped prior to trigger point injections, although less “fanning” is recommended to avoid significant hematoma formation.</td>
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<td></td>
<td>Bleeding</td>
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<td>Vasovagal syncope</td>
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<td>Pneumothorax</td>
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**HOW TO PERFORM**

- An appropriately sized needle is repeatedly inserted into the myofascial trigger point in a fan-like manner (“fanning”) to cause muscle-fiber relaxation and lengthening, and disrupt the connective tissue.
- Larger needles are used for larger muscle groups such as the lumbar paraspinal muscles. Shorter needles (1/2- to 5/8-inch needles) are used for smaller muscles or if there is increased risk for pneumothorax (e.g., in the cervical or thoracic paraspinal region).
- Dry needling is the insertion of the needle without any injection, whereas trigger point injections involve injection of saline or a local anesthetic (avoiding long-acting anesthetics such as bupivacaine, as they can be myotoxic). Glucocorticoids are generally also best avoided given concerns about systemic side effects and myotoxicity.

**References:**
Minimally invasive surgical procedures represent an essential, evolving approach to treating chronic pain. Currently, there are two broad categories of these procedures: intrathecal drug delivery and neuromodulation.

**Intrathecal Drug Delivery.** These procedures directly deliver medications into the cerebral spinal fluid, thereby having potent analgesic effects while minimizing systemic adverse effects from oral administration of medication. The only FDA-approved medications for intrathecal delivery are morphine, ziconotide, and baclofen. In practice, however, other agents are also used; these include hydromorphone, fentanyl, clonidine, and a local anesthetic (such as bupivacaine). When monotherapy fails to provide adequate analgesia, combinations of several classes of medications are used instead, most commonly in the form of mixed opioid and local anesthetic solutions.

**Neuromodulation.** The mechanism of action of neuromodulation is only partially understood. One proposed mechanism is based on the “gate-control” theory of pain: The neuromodulation device provides an electric signal, which serves as a nonpainful stimulus, thereby modulating pain transmission in the central nervous system. This “closing the gate” to the transmission of painful sensations leads to analgesia. Spinal cord stimulation and peripheral nerve stimulation are two types of neuromodulation.
Intrathecal Drug Delivery

### INDICATIONS
- Malignant pain
- Nonmalignant pain
- Spasticity

Patients must have persistent, debilitating pain or spasticity that is not responsive to more-conservative treatments.

### POTENTIAL COMPLICATIONS
- Intraoperative injury to the nerve roots or spinal cord
- Bleeding and hematoma formation
- Infection: Deeper infection may require explantation of the entire system.
- Catheter-related malfunctions (e.g., kinks)
- Intrathecal granuloma (rare but serious)

### CLINICAL PEARLS
- Intrathecal therapy, especially in advanced cancer and in patients with upper neuron spasticity, has been shown to provide improved analgesia with fewer side effects, compared with oral therapy.

### HOW TO PERFORM

Patients for whom intrathecal drug delivery is being considered must first undergo a trial of neuraxially administered medication (local anesthetic ± opioid or baclofen) to determine whether therapy will provide an adequate clinical effect. Although epidural and intrathecal single-shot trials can be done, the preferred method involves placement of an intrathecal catheter to best mirror potential implant conditions. Hospital admission is generally recommended to monitor for adverse effects while adjusting the continuous epidural infusion to achieve efficacy. A successful trial is usually defined as an at least 50% improvement in pain and/or functional status.

If there is benefit, the patient is taken to the operating room, where the procedure is done under fluoroscopic guidance. Intravenous access is required. Depending on physician preference and patient comorbidities, the procedure can be performed with local anesthesia and sedation or general anesthesia. Prophylactic antibiotics (e.g., cefazolin) also are required before surgery.

A catheter is first placed into the epidural space under fluoroscopic guidance. The location is chosen to correspond to the dermatome that corresponds to the center of the patient’s pain. Up to 6 spinal segments are usually covered well by an intrathecal opioid infusion, but as many as 10 segments may be reached.

The catheter is tunneled under the skin of the abdominal wall and connected to the infusion pump. The pump is typically placed in the anterior abdominal wall for easy access. Patients recover quickly after surgery and usually return to their normal activities within one month.

The patient needs follow-up every 1 to 3 months for pump refills, whereby leftover medicine is extracted by a needle percutaneously from the reservoir, and replaced with new medication(s). The pump reservoir needs to be exchanged every 7 to 10 years via a minimal surgical procedure.

### REFERENCES


Neuromodulation (Spinal Cord Stimulation)

<table>
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<tr>
<th>INDICATIONS</th>
<th>POTENTIAL COMPLICATIONS</th>
<th>CLINICAL PEARLS</th>
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<tbody>
<tr>
<td>Spinal cord stimulation (SCS) is a treatment option for severe neuropathic pain that is not responsive to more-conservative treatments.</td>
<td>■ Bleeding and hematoma formation (around pocket area or epidural space)</td>
<td>■ Neuromodulation has shown substantial advancement in the past several years, with significant improvement in the device itself and inclusion of more indications.</td>
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<td>Common indications:</td>
<td>■ Infection (deeper infections may require explantation of the entire system)</td>
<td>■ However, it remains a technically challenging surgical pain-management procedure that merits extensive training and understanding of neuroanatomy, surgical technique, and perioperative patient care.</td>
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<td>■ Failed back surgical syndrome</td>
<td>■ Postdural headache</td>
<td>■ When performed by experienced providers, it offers a viable alternative to patients who have persistent pain despite maximizing other treatments, with fewer overall side effects.</td>
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<td>■ Complex regional pain syndrome (CRPS) types 1 and 2</td>
<td>■ Spinal cord or nerve root damage</td>
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<td>■ Painful radiculopathies</td>
<td>■ Lead migration and lead fracture, evidenced by loss of analgesia</td>
<td></td>
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<tr>
<td>■ Painful diabetic neuropathy</td>
<td>Other indications:</td>
<td></td>
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<tr>
<td>HOW TO PERFORM</td>
<td>■ Painful peripheral vascular disease</td>
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<td>Patients in whom spinal cord stimulation is being considered must first undergo a 7- to 10-day trial. One or two leads are inserted percutaneously under fluoroscopic guidance and advanced in the epidural space to the desired locations. For low-back or lower-extremity pain, a common epidural entry site is L1–L2 with the leads located at the top of T8 and mid-T9 vertebrae. For upper-extremity pain, a common epidural entry site is T1–T2 with an electrode tip at C2. During the trial, the leads are attached to an external generator, and the patient’s pain level, function, and quality of life are assessed. A successful trial is defined as showing at least a 50% improvement in pain or functional status. At the end of the trial, the leads are removed and discarded.</td>
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<td>If there is benefit, the patient returns for implantation of the permanent device. This procedure is done in the operating room under monitored anesthesia care and fluoroscopic guidance. Prophylactic antibiotics (cefazolin) are required before the trial and permanent surgical implant.</td>
<td>A lead is placed in a similar manner to the placement during the trial, and it is tunneled subcutaneously to the implantable pulse generator. The pulse generator is usually placed in the lower abdominal wall area, either on the left or right side depending on patient preference. Generally, the device is not turned on until the 1-week follow-up appointment (when surgical pain subsides).</td>
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<td>Patients have quick surgical recovery. They usually return to light work within 5 to 7 days and can perform graded strenuous activities after one month. The generator is charged externally every 1 to 3 days, and it needs to be exchanged every 7 to 10 years via a minimal surgical procedure.</td>
<td>Reference: Kumar K et al. The effects of spinal cord stimulation in neuropathic pain are sustained: A 24-month follow-up of the prospective randomized controlled multicenter trial of the effectiveness of spinal cord stimulation. Neurosurgery 2008; 63:762.</td>
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</tbody>
</table>
Peripheral nerve stimulation is typically performed under local anesthesia. Using ultrasound guidance, the clinician injects a local anesthetic along the track of proposed needle insertion. A monopolar needle is then inserted, again under ultrasound guidance, up to 0.5 cm to 1 cm from the target nerve. An electrical stimulator is attached to the needle to deliver a test stimulation. The stimulator needle is readjusted until uncomfortable sensations and muscle contractions are no longer present.

Once the stimulator needle is confirmed to be in the correct position, it gets withdrawn, and the introducer needle preloaded with the stimulator lead is placed in the same location. The needle is then removed over the stimulator lead, and the lead can then be attached to the generator, which is generally placed externally.

Appropriate placement results in comfortable sensations in the desired region without muscle contractions when electrical stimulation is on.

Reference:
COMMON INTERVENTIONAL PAIN PROCEDURES


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Figures:

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