Caudal Epidural Injection

55

Atul A. Walia, Hiep Tran, and Dan DuBose

Introduction

Caudal epidural injections have been used in medicine for many years and extensively in pediatrics, obstetrics, and interventional pain medicine. Obstetric anesthesia has largely replaced this technique with lumbar epidural catheters for labor, but pediatric anesthesia and pain management still use it in daily practice. Pediatric anesthesiologists often use local anesthetics in caudal epidural nerve blocks for analgesia in surgeries below the umbilicus. Pain management physicians typically inject local anesthetics with or without corticosteroids in the caudal epidural space to treat pain from lumbar spinal stenosis, failed back surgery syndrome, lumbar radiculopathy, and other etiologies of low back pain.

Interventional pain management is a field that is rapidly advancing in technology and techniques. The caudal epidural injection is one of the oldest epidural injection techniques, and it continues to be used in pain management practices today. The physician must understand the anatomy, limitations, risks, and benefits before proceeding. Although the injection site is below the dural sac, inadvertent dural puncture and intrathecal injection are still a risk. Other risks include intravascular injection, bleeding, infection, epidural hematoma, and postdural puncture headache. Caudal epidural injections should not be performed in patients with an active infection, pilonidal cyst, or certain coagulopathies. There are situations where patients can discontinue their anticoagulation medications prior to caudal epidural injection.

The caudal approach to the epidural space offers several advantages compared to other epidural injections. It is considered safer because the injection occurs below the level of the dural sac, which makes intrathecal injection less likely. Well-defined landmarks make identifying the injection site possible without fluoroscopy, which is helpful for physicians who do not have fluoroscopy in their office or are traveling overseas for humanitarian work. Patients with previous back surgeries often have altered anatomy or implanted hardware that make epidural injections difficult to perform, and the caudal epidural injection provides a safe alternative for these patients.

Background and Historical Perspective

Caudal epidural injections have been used in medicine for many years. The technique was first described in the early 1900s for the treatment of sciatic pain and low back pain as well as in urologic procedures. The first anesthetic used was cocaine, which had some unpleasant side effects. Over time, newer local anesthetics were developed with improved side effect profiles. Corticosteroids were first administered through caudal epidural injections in the 1950s. Today, pain management physicians perform caudal epidural injections with local anesthetics with or without corticosteroids.

Multiple approaches to the epidural space are available. Interlaminar injections deliver the medication close to the presumed site of pathology. Transforaminal injections are considered to be target-specific and require the lowest volume of medication to reach the site of pathology. Caudal epidural injections are considered to be the safest and easiest, with the least likelihood of unintentional dural puncture. They require larger volumes of medication and can be performed without fluoroscopy if needed.

Chronic low back pain is one of the most common causes of pain in the United States. It is estimated that more than

A. A. Walia (✉)
Integris Pain Management, University of Oklahoma Health Sciences Center, Oklahoma City, OK, USA

H. Tran
Department of Anesthesiology, Baylor Scott and White Health, Temple, TX, USA

Texas A&M University College of Medicine, Killeen, TX, USA

D. DuBose
Department of Anesthesiology, Baylor Scott and White Health, Temple, TX, USA

T. R. Deer et al. (eds.), *Deer's Treatment of Pain*, https://doi.org/10.1007/978-3-030-12281-2_55

100 million people suffer from chronic low back pain. Billions of dollars are spent on the diagnosis and treatment of back pain every year. Physical therapy, chiropractors, massage therapy, exercise, medications, procedures, and surgical procedures are just a few of the many treatment modalities employed to tackle this problem. For many patients, a surgical procedure is the last resort after all conservative options have been exhausted. Caudal epidural injections can obviate the need for surgery, and for others, they are a bridge to a surgical intervention.

There has been an explosion in the number of epidural injections performed by physicians during the last 20 years. One of the earliest specialties to use caudal epidural injections was obstetrics. Initially, analgesia was obtained by a single injection into the epidural space through the sacral hiatus. In the 1930s, obstetricians began leaving a catheter in the epidural space, allowing them to give repeated doses of medication without performing multiple procedures. Over time, lumbar epidural catheters have become the predominant method to provide labor analgesia because they make it is easier to position patients for the procedure and allow physicians to use the catheter for cesarean sections if needed.

Caudal epidural nerve blocks were first used in pediatric surgery in the 1930s, and they continue to be a pillar of pediatric regional anesthesia. They were first used in urological surgeries but quickly expanded to other surgical procedures. Caudal anesthesia allows for excellent postoperative pain control as well as less opioid use intraoperatively. Today, pediatric anesthesiologists routinely perform caudal epidural nerve blocks for surgical procedures below the umbilicus.

Uses and Indications

Caudal epidural injections are one of the most commonly performed epidural injections. They have been used for many years to treat various conditions. They are used extensively in pediatric anesthesia and in interventional pain management. In pediatric anesthesia, caudal epidural nerve blocks are used for intraoperative and postoperative analgesia for surgical procedures below the umbilicus. Interventional pain physicians frequently perform caudal epidural injections of local anesthetics with or without steroids for lumbar spinal stenosis, failed back surgery syndrome, and lumbar radiculopathy. Other indications include pelvic pain syndromes, postherpetic neuralgia, chronic pain from rectal malignancies, or bony metastasis to the lumbar spine. Caudal epidural nerve blocks can also be used for adults undergoing surgical procedures below the umbilicus; however, they are used in adults less frequently than in pediatric patients. Acute pain management services also perform caudal epidural nerve blocks for postoperative pain as well as other acute pain crises.

Knowing anatomy is imperative for performing successful interventional procedures. The spinal cord ends at L1 to L2 in adults and L2 to L3 in neonates and infants. The dural sac continues caudally and terminates at S1 to S2 in adults and S2 to S3 in neonates and infants. The sacrum is the most caudal border of the spinal canal. It is a triangular-shaped bone that is made up of five fused vertebrae (see Fig. 55.1). It articulates with the fifth lumbar vertebra at the cephalad end and the coccyx on the caudad end. The sacral spinous processes make up the median crest. The sacral cornua and coccygeal cornua are palpable landmarks that help in identifying the sacral hiatus. The sacral hiatus is found on the posterior wall of the sacrum. It is an inverted U shape that is covered by the sacrococcygeal ligament and serves as the entry point for caudal epidural injections. Significant variations exist in the depth of the sacral canal and the distance from the entry point to the dural sac. This variability is one reason that some argue for using fluoroscopy to ensure a safe and successful injection. The anterior and posterior rami of S1-S4 exit the canal through the anterior and posterior sacral foramina, respectively. The S5 nerve roots and coccygeal nerves exit the canal through the sacral hiatus. The epidural space is filled with veins, arteries, fat, and lymphatics. The epidural venous plexus typically terminates around S4. It is mostly located against the anterolateral portion on the sacrum. The majority of the epidural space in the sacral canal is filled with fat, which decreases in density with aging. This decrease likely accounts for the unpredictable spread of medications in older patients.

In the perioperative setting, caudal epidural nerve blocks are used extensively in the pediatric population undergoing surgical procedures of the perineum and rectum, urologic procedures, femoral and inguinal herniorrhaphy, and other operations below the umbilicus. Due to potential postoperative motor blockade, these nerve blocks are most frequently performed in children who have not yet started walking. The landmarks are much easier to palpate in the pediatric population, which makes it easier to perform without fluoroscopy. The nerve block is typically performed under general anesthesia in the lateral position.

Caudal epidural nerve blocks can also be performed in adults for perioperative analgesia. They work well for surgical procedures involving the rectum and pelvis. Acute pain management services perform caudal epidural nerve blocks for postoperative pain management. Some of the common indications include pain from lower extremity trauma as well as pain due to pelvic, genital, and rectal malignancies and bony metastasis to the lumbar spine. Prolonged motor blockade can cause prolonged stays in the recovery room and is not ideal for outpatient surgical procedures. Several notable differences between adult and pediatric patients have been observed. In adults, caudal epidural nerve blocks are typically performed in the prone position, but the lateral position

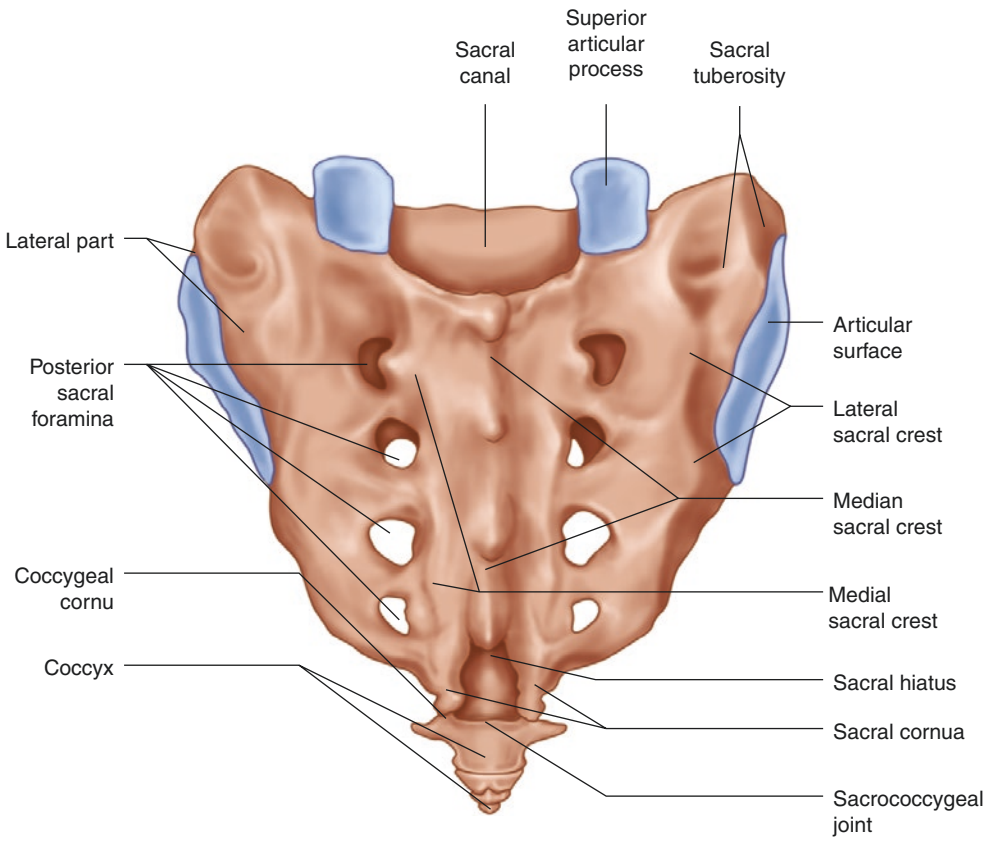

Fig. 55.1 Sacrum

is possible if a patient cannot lie prone or if the physician prefers this position. Fluoroscopy is optional and used less frequently in the perioperative setting. Although some studies advocate for the use of fluoroscopy for more successful placement, it is not always available in these settings. The landmarks are the same in the adult population; however, they may be more difficult to feel due to body habitus. The sacrococcygeal ligament can undergo calcification as people age, which can be a barrier to this technique in the elderly population.

Pain management physicians frequently perform caudal epidural injections with local anesthetics with or without corticosteroids. Most commonly they are performed for lumbar spinal stenosis, failed back surgery syndrome, and lumbar radiculopathy. Other indications include pelvic pain syndromes, postherpetic neuralgia, chronic pain from rectal malignancies, or bony metastasis to the lumbar spine.

Failed back surgery syndrome is one of the common indications for caudal epidural injections. A potential mechanism for continued back pain following a surgical procedure seems to be epidural fibrosis and scar tissue that impinge on nerve roots. Other causes of persistent pain following back surgery include facet joint pain, sacroiliac joint pain, spinal stenosis, discogenic pain, herniated disc, and paraspinal muscle spasms. Patients with failed back surgery syndrome often have pathology that makes interlaminar and transforaminal epidural injections difficult. Pedicle screws used in spinal fusion can make the transforaminal approach difficult, and a patient who has had a laminectomy is no longer a candidate for the interlaminar epidural approach. The caudal approach allows the physician to avoid hardware while still reaching areas of the lumbar spine in patients that would otherwise be difficult to treat.

Severe spinal stenosis is another common indication for caudal epidural injections. Not surprisingly, spinal stenosis is also one of the most common indications for back surgery. Spinal stenosis is a narrowing of the spinal canal with compression of the neural structures by bone and soft tissue. The mechanism of pain from nerve compression with stenosis is not fully understood. However, inflammation and nerve compression might explain why corticosteroids are believed to be helpful. Another postulated mechanism is ischemic pain due to central canal narrowing. Lumbar extension reduces the cross-section area of the central canal, which compresses the vasculature supplying nerve roots and causes ischemic pain. This explains the reversible nature of spinal stenosis pain with flexion of the lumbar spine.

Caudal epidural injections performed by interventional pain physicians are typically done in the prone position with fluoroscopic guidance. The patient is positioned with a pillow under the head and another pillow under the hips. Abduction of the legs and heels prevents the patient from

tightening gluteal muscles, which makes palpation of the landmarks easier. Wide preparation with an antiseptic solution is imperative, and a sterile drape is applied. The Center for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infections recommends skin preparation with an alcohol-based antiseptic agent unless contraindicated.

The tip of the coccyx is palpated, identifying the sacral midline. The sacral cornua can be palpated just lateral to the midline. This should be the level of the sacral hiatus. At this point, the C-arm is positioned in the anteroposterior (AP) or lateral position. The sacral hiatus is difficult to identify in the AP position, so it is recommended to start in the lateral position. The posterior sacral plate can be followed down to its most inferior aspect. This should be the superior aspect of the sacral hiatus. Once the needle insertion point has been determined, a skin wheel is made with subcutaneous injection of 1% lidocaine. A 22 gauge, 1.5-inch needle is inserted at a 45-degree angle into the sacrococcygeal ligament (see Fig. 55.2). When the needle penetrates the sacrococcygeal ligament, a distinct pop is felt. After the needle has passed through the ligament, the angle of the needle is decreased, and the needle is advanced 1–2 cm into the spinal canal. To stay safely below the dural sac, the needle should not go beyond S3. AP and lateral images will confirm proper needle position in the sacral canal (see Fig. 55.3). Keep the needle midline in the sacral canal, and the needle bevel tip can be rotated to direct medications toward the patient's most symptomatic side if applicable. Once you are confidently in the sacral canal, gently aspirate to check for the return of cerebrospinal fluid or blood. If either is positive, the needle should be withdrawn slightly and repositioned. After negative aspiration, 1–1.5 ml of nonionic radiographic contrast should be injected under live fluoroscopy to rule out intravascular placement or intrathecal injection (see Fig. 55.4). Once proper caudal epidural needle placement has been confirmed, local anesthetic with or without

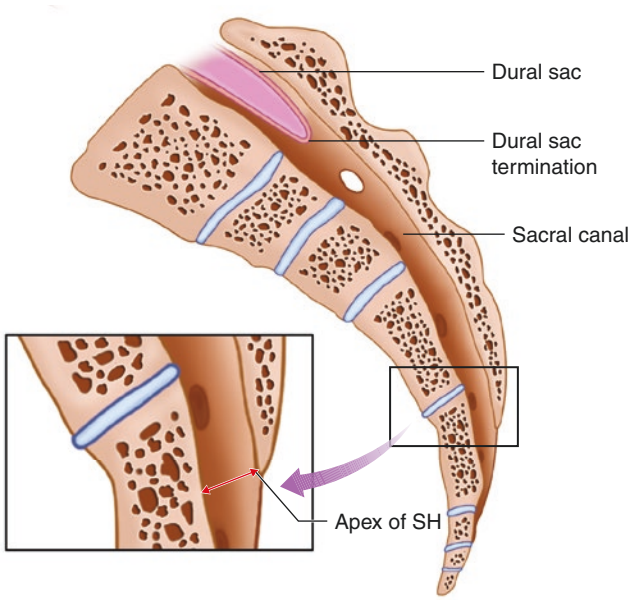

Fig. 55.2 Needle is inserted at a 45-degree angle into the sacrococcygeal ligament

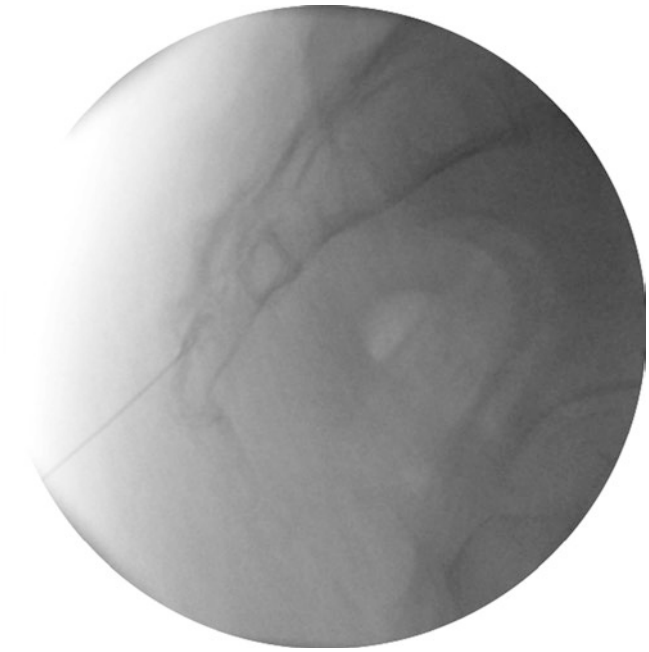

Fig. 55.3 Proper needle position in the sacral canal

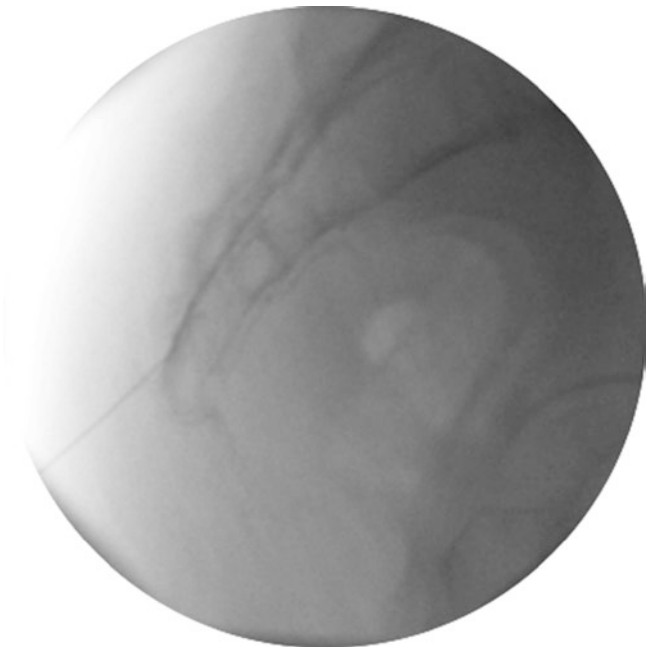

Fig. 55.4 Nonionic radiographic contrast confirming proper placement

corticosteroids is injected into the caudal epidural space. If a steroid is used, follow the injection with 2 ml of sodium chloride. Remove the needle and hold pressure until sufficient hemostasis is achieved.

Caudal epidural injections can be performed with local anesthetic with or without steroids. Recently much discussion has taken place about the type of steroid added to the injection. Steroids can be broken down into two broad categories: particulate and nonparticulate. Particulate steroids are typically poorly soluble in water and, therefore, may precipitate out of solution and crystalize in a hydrophilic environment. Examples of particulate steroids include triamcinolone acetonide, betamethasone acetate, methylprednisolone acetate, and prednisolone acetate. In contrast, nonparticulate steroids are freely water soluble. Dexamethasone sodium phosphate is an example of a nonparticulate steroid. Particulate steroids have generated some controversy. Serious complications have occurred following epidural injection of particulate steroids, including infarction of the cerebellum, brainstem, and thalamus as well as the cervical and lumbar spinal cord. Nonparticulate steroids have not been attributed to these same complications. However, the pathophysiology of paraplegia associated with epidural steroid injections is unclear. Studies have suggested that nonparticulate steroids are not as effective as particulate steroids for pain relief. These controversies should lead the administering physician to be aware of the risks and benefits of each steroid before choosing the type of steroid to be used.

The caudal epidural space can accommodate larger volumes of injectate. The volume of the sacral canal has been measured to roughly 30–34 mL in dried bone models. The range of injectate has been reported from as low as 5 mL to as high as 20 mL. The typical caudal epidural injection is 10 mL.

Several filling patterns that can result when contrast is injected under fluoroscopy are worth noting. An irregular or cotton-ball appearance is suggestive of an extra-epidural injection. Rapid filling and disappearance under live fluoroscopy is suggestive of an intravascular injection. Intrathecal injection will result in myelographic patterns, with contrast in the thecal sac and lumbar nerve roots appearing radiolucent as they are surrounded by contrast within the cerebrospinal fluid.

Ultrasound is being used more frequently for spine procedures including caudal epidural injections. It is excellent for visualizing soft tissues and real-time needle manipulation as well as major nerves and blood vessels. It can be used in situations when fluoroscopy is not available or when radiation should be avoided, such as in pregnancy. Ultrasound has several limitations. Deep structures can be difficult to visualize, and the bone obstructs visualization of objects beneath it. Accidental intravascular injection is better detected under fluoroscopy than ultrasound.

Table 55.1 Evidence for efficacy

	Local anesthetic	Local anesthetic + steroid
Lumbar disk herniation	fair	good
Axial pain	fair	fair
Spinal stenosis	fair	fair
Post-surgery syndrome	fair	fair

Evidence for Efficacy

The American Society of Interventional Pain Physicians publishes evidence-based guidelines for interventional techniques, as summarized in Table 55.1. They develop their recommendations by performing a systematic assessment of the most recent literature and classify them according to the US Preventive Services Task Force (USPSTF) criteria of good, fair, and poor.

The evidence is good for short-term and long-term relief in lumbar disc herniation with radiculitis treated with local anesthetics with steroids. The evidence is fair for short-term and long-term relief with local anesthetics only. The evidence is fair for discogenic or axial pain without disc herniation, radiculitis, sacroiliac joint pain, or facet joint pain. The evidence is fair for long-term relief in spinal stenosis treated with local anesthetic with or without steroids. The evidence is fair for post-lumbar surgery syndrome treated with local anesthetics with or without steroids.

Pearls and Pitfalls

- Caudal epidural injections provide a safe method of epidural injections in patients with lumbar hardware from previous back surgeries.
- Caudal epidural injections are safer and may be as efficacious as interlaminar and transforaminal epidural injections.
- Thorough and wide preparation with an alcohol-based antiseptic solution is imperative given the location of this injection.
- Caudal epidural injections can be with local anesthetic alone or with corticosteroids.
- In adults, to avoid inadvertent dural puncture and intrathecal injection, do not advance your needle past S3.
- Understand the risks associated with caudal epidural injections, including inadvertent dural puncture and intrathecal injection, intravascular injection, bleeding, infection, epidural hematoma, and postdural puncture headache.
- Absolute contraindications are active infection, pilonidal cyst, and certain coagulopathies. There are situations where patients can discontinue their anticoagulation medications prior to caudal epidural injection.

- Having the C-arm in the lateral position provides the best image of the location of the sacral hiatus.
- Abduction of the legs and heels prevents the patient from tightening their gluteal muscles, which makes palpation of the landmarks easier.
- The evidence is good for managing disk herniation or radiculitis with caudal epidural injections.
- The evidence is fair for managing axial or discogenic pain without disk herniation, radiculitis, or facet joint pain with caudal epidural injections.
- The evidence is fair for managing spinal stenosis with caudal epidural injections.
- The evidence is fair for managing failed back surgery syndrome with caudal epidural injections.

Recommended Reading

1. Brown TC. History of pediatric regional anesthesia. Paediatr Anaesth. 2012;22(1):3–9.
2. Conn A, Buenaventura RM, Datta S, Abdi S, Diwan S. Systematic review of caudal epidural injections in the management of chronic low back pain. Pain Physician. 2009;12(1):109–35.
3. Friedman JH, Dighe G. Systematic review of caudal epidural injections in the management of chronic back pain. R I Med J. 2013;96(1):12–6.
4. Karkera MM, Harrison DR, Aunspaugh JP, Martin TW. Assessing caudal block concentrations of bupivacaine with and without the addition of intravenous fentanyl on postoperative outcomes in pediatric patients: a retrospective review. Am J Ther. 2016;23(3):e792–8.
5. Kaye AD, Manchikanti L, Abdi S, et al. Efficacy of epidural injections in managing chronic spinal pain: a best evidence synthesis. Pain Physician. 2015;18(6):E939–1004.
6. Manchikanti L, Singh V, editors. Interventional techniques in chronic spinal pain. Paducah: American Society of Interventional Pain Physicians; 2007.
7. Manchikanti L, Cash KA, McManus CD, Pampati V, Abdi S. Preliminary results of a randomized, equivalence trial of fluoroscopic caudal epidural injections in managing chronic low back pain: part 4--spinal stenosis. Pain Physician. 2008;11(6):833–48.
8. Manchikanti L, Singh V, Cash KA, Pampati V, Damron KS, Boswell MV. A randomized, controlled, double-blind trial of fluoroscopic caudal epidural injections in the treatment of lumbar disc herniation and radiculitis. Spine (Phila Pa 1976). 2011;36(23):1897–905.
9. Manchikanti L, Cash KA, McManus CD, Pampati V, Fellows B. Results of 2-year follow-up of a randomized, double-blind, controlled trial of fluoroscopic caudal epidural injections in central spinal stenosis. Pain Physician. 2012a;15(5):371–84.
10. Manchikanti L, Singh V, Cash KA, Pampati V, Datta S. Fluoroscopic caudal epidural injections in managing post lumbar surgery syndrome: two-year results of a randomized, double-blind, active-control trial. Int J Med Sci. 2012b;9(7):582–91.
11. Manchikanti L, Falco FJ, Pampati V, Cash KA, Benyamin RM, Hirsch JA. Cost utility analysis of caudal epidural injections in the treatment of lumbar disc herniation, axial or discogenic low back pain, central spinal stenosis, and post lumbar surgery syndrome. Pain Physician. 2013a;16(3):E129–43.
12. Manchikanti L, Abdi S, Atluri S, et al. An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain. Part II: guidance and recommendations. Pain Physician. 2013b;16(suppl 2):S49–283.
13. Manchikanti L, Pampati V, Falco FJ, Hirsch JA. Assessment of the growth of epidural injections in the medicare population from 2000 to 2011. Pain Physician. 2013c;16(4):E349–64.
14. Manchikanti L, Benyamin RM, Falco FJ, Kaye AD, Hirsch JA. Do epidural injections provide short- and long-term relief for lumbar disc herniation? A systematic review. Clin Orthop Relat Res. 2015;473(6):1940–56.
15. Parr AT, Manchikanti L, Hameed H, et al. Caudal epidural injections in the management of chronic low back pain: a systematic appraisal of the literature. Pain Physician. 2012;15(3):E159–98.
16. Rathmell JP. Atlas of image-guided intervention in regional anesthesia and pain medicine. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2012.
17. Rho ME, Tang CT. The efficacy of lumbar epidural steroid injections: transforaminal, interlaminar, and caudal approaches. Phys Med Rehabil Clin N Am. 2011;22(1):139–48.
18. Silva M, Halpern SH. Epidural analgesia for labor: current techniques. Local Reg Anesth. 2010;3:143–53.
19. Waldman SD. Atlas of interventional pain management. 3rd ed. Philadelphia: Saunders Elsevier; 2009.