INJECTION TECHNIQUES IN MUSCULOSKELETAL DISORDERS

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JAYPEE
Injection Techniques in Musculoskeletal Disorders

First Edition: 2013
Printed at
Dedicated to

Dr Narayan Dutt Shrimali
Preface

The purpose of this book is to discuss pain management, the various disorders in which pain constitutes a major problem and the method employed in its management, with special emphasis on the use of ultrasound and image intensifier as an aid in the diagnosis and therapy. Goal is to achieve completeness from standpoint of surgeons and radiologists. This book is written with my desire to facilitate busy surgeons and to provide information with the conviction that this will induce more clinicians to employ these methods of therapy.

This book has been developed to meet the need for a text that gives technical details that the surgeon must know to perform these intricate procedures well. The emphasis throughout is on the details essential for rapid, smooth and complication-free procedure. I have written highly focused chapters, which describe preferred methods of performing specific interventions in our institutes, including hints and fine points that have proven of value in our own experiences. A particularly important feature of each chapter is the discussion of how to avoid pitfalls.

This book describes methods to visualize various structures with ultrasound and provide local injections at places where blind procedures are harmful. Historical aspects and compilations of results are mentioned only in passing, although necessary data are provided to justify the recommendations.

The idea behind this book is to visualize the structure before intervention, so that, exact site of pathology is encountered. Thus, reducing side effects of procedure and also it becomes safe procedure. The text has been organized with the aim of making it as useful as possible to surgeons as well as to radiologists. The eight chapters in this book provide an overview of the principles important to successful treatment.

I learned much in the process of writing this book and hope that you will find it a valuable resource.

Janak Parmar
I am very thankful to:

• All those who made the writing of this book possible, in particular, Dr AG Ambardekar, Dr BG Kanaji, Dr Nilesh Vishvakarma, Dr Rohit Dharmadhikari and the residents at Mumbai Port Trust Hospital, Mumbai, Maharashtra, India.

• Dr Ramesh Agarwal, Head, Department of Radiology, Mumbai Port Trust Hospital, for his guidance on ultrasound examination techniques.

• Mr Pradeep Adhikari and Mr Wadekar, who helped me in making diagrams in this book.

• Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Managing Director) and Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for publishing the book in the same format as wanted well in time.

• Mr KK Raman, Mr Subrata Adhikari, Mr Rajesh Sharma, Mr Sunil Rawat and Mr Sarvesh Singh of Jaypee Brothers, New Delhi, who gave me the opportunity to produce this manuscript.

• Mr Ramesh Krishnamachari Iyengar (Commissioning Editor, Mumbai Branch), for introducing me to Jaypee Brothers.

• My parents, Mr Hasmukh Parmar and Mrs Bharati Parmar, Mr Chandrakant Margaj, Mrs Vidya Margaj, who all gave me immense support to complete this book.

• Dr Vishrabdha Margaj, for her encouragement in completing this book.
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How to Use the Book

At various chapters the ultrasonography pictures have (*) mark, this mark shows the exact site of needle tip when seen on real time ultrasonography. The needle needs to be visualized on ultrasound when inserted before injectate is provided to look at the exact site of injection. The USG probe is held with one hand and syringe with needle is held with other hand.

In various books, two methods of injecting are given, here I present the method followed commonly—the drug and local anesthetic is mixed in the same syringe before injection. One can also use other technique in which when needle is inserted at superficial site first, the syringe filled with local anesthetic is attached, injection is given and keeping the needle at the same position or inserted at more deep definitive site, second syringe with steroid/drug is attached and injected.

The indications for various conditions may vary and depending on patient and disease, but these indications are generally followed.

Wherever relevant, the positions of USG probe for visualizing the structures are presented, but in general it should follow standard longitudinal and transverse positions. More important is to visualize the structure in total, whatever plane is used and to confirm it with moving that structure then stabilizing the USG probe and injecting.

Always use sterile cover for USG probe/clean the probe with proper solution before using it over the draped part.
In this chapter various spinal conditions are highlighted. It is essential to define proper indication for providing injection. Usually nerve root blocks and facet joint blocks are provided image intensifier guided and this area is very site specific as slight mistake may lead to wrong site of injection and patient may not get relief of pain. Also surrounding structures need to be protected while giving injections as it may injure neural structures.

ANATOMICAL AND PHYSIOLOGICAL CONSIDERATIONS (FIGS 6.1 TO 6.12)

Spinous processes of L4-L5 correspond to iliac crest level are excellent reference points.

- S2 spinous process lies at level of posterosuperior iliac spine.
- Posterior aspect of coccyx can be felt directly.
- In thin individuals, sacral promontory (L5-S1 articulation) can be felt below umbilicus anteriorly, and at umbilicus the level is L3-L4.

Fig. 6.1: X-ray LS spine showing spondylosis
Spinal cord in adults extends down to level of lower border of spine of L1; in young children, it may extend to L3.

Subarachnoid space with its cerebrospinal fluid (CSF) extends down to lower border of S1 which lies at the level of posterosuperior iliac spine.
Pain sources may be diskogenic, facetal, spondylogenic, referred, radicular, myofascial, vascular and retroperitoneal.

Facet joints are innervated by medial branch of dorsal primary rami.

Structures within neural canal are—sinovertebral nerve, disk, a branch of rami communicates and ventral primary ramus.
Fig. 6.6: Spine anatomy on lateral view.

Fig. 6.7: Surface landmarks of lumbar spine

Fig. 6.8: Anatomy of spine
Fig. 6.9: Degenerative lumbar spine

Fig. 6.10: Degenerative lumbar spine and facetal arthritis

Fig. 6.11: Relation of nerve root with facet joints, disk and its branches
Pain is mediated by TNF-alpha, IL-1, substance P and vasoactive intestinal peptide (VIP). Laslett et al and Manchikanti et al (2001) have described discography as a way of diagnosing.

**ALBERT SCHWEITZER**

“We must all die but that, I can save him from days of torture that’s what, I feel is my goal and ever new privilege. Pain is more terrible long of mankind than even death itself.”

Harshall et al—prevalence of chronic pain is 10% to 55% and in elderly it is 23.7% to 50.2%.

“Patients suffering from chronic pain often have damage to a nerve and that nerve is in a constant state of aggravation sending pain messages up and down its entire length,” said Kim J Burchiel, MD.

In some cases, painful nerve damage cannot be repaired.

Low back pain and sciatica:

- Has nociceptive inflammatory pain mechanism
- There is activation and sensitization of nerve root (nervi nervorum) from root compression or traction
- There is sensitization of nociceptors of annulus fibrosus, periosteal spinal structures and ligaments due to acute inflammation
- Hyperalgesia (deep spinal and dermatomal) due to central sensitization
- Radicular and diskogenic, neuropathic pain:
  - Mechanism
    - Ectopic activity of nerve root nervi nervorum; sensitization and ectopic activity of nociceptive innervating spinal periosteal structures.
- There is possible role of abnormal nociceptors overgrown within intradiskal space, postsurgical epidural scars and degenerated facet joints
- There is CNS sensitization and reorganization.
Bulging disk:
- 3/4 MRI bulging disks are normal.
- In 1/2 with persistent sciatica, MRI is show only a bulge.
- 10% show nerve root compression.
- 50% painful disk missed by CT.
- 2/3 asymptomatic have spine MRI abnormalities.

Low back pain similar to preoperative symptoms, noted in 70% patients after stimulation of posterior annulus or posterior longitudinal ligament, local anesthetic injection obliterated pain.

Facet joint pain have no objective findings except tenderness. It could have back pain not aggravated by movements.

Hypertrophied facet joints are less likely to hurt (Kalichman L et al).

There is no significant relation in imaging findings and facet pain (Cohen S et al 2007).

Disk herniation causes:
- Spinal nerve root compression
- Spinal nerve root inflammation
- Spinal stenosis.

Correlating physical findings with imaging decides level and type of injection.

Patient walks with list.

Spinal stenosis:
- Back and leg pain after walking a limited distance and increasing as distance increases.
- There is leg weakness or numbness with or without sciatica.
- Negative straight leg raising test.
- Pain present on prolonged extension decreasing on flexion.

Facet joint arthropathy:
- Pain over facet joint on spinal extension
- Exacerbation by ipsilateral trunk lateral flexion.

Always keep in mind compression from piriformis:
- Symptoms similar to lumbar disk conditions except for absence of true neurological finding.
- Pain increases with medial rotation of thigh.

Pathology
- High levels of phospholipase A2(PL-A2) enzyme that helps to regulate the initial inflammatory cascade. It causes local demyelination of nerve roots with ectopic diskharges.
- Inflammatory products leukotriene-B4 and thromboxane-B2 have also been recovered in herniated human disk after surgery.
- Spinal stenosis causes nerve root vascular flow inhibition with resulting nerve root edema, nerve root dysfunction and decreased nerve root nutrition.
- Compression or irritation of dorsal root ganglia can lead to sensitization and resultant radicular pain.
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- Chronic nerve root compression can induce axon ischemia, impede venous return, promote plasma protein extravasation.
- Decreased capillary permeability.
- Decreased neural transmission in nociceptive ‘c’ fibers.
- When nerve roots exit the thecal sac, they are covered by a short expanse of dural membrane, they are enveloped within the epidural fat.
- Nerve roots and associated radicular vessels and lymphatics then course in an oblique fashion in lumbar spine, inferior to the corresponding pedicle and through neural foramina.
- At exit zone of neural foramina lies dorsal root ganglion which has preponderance of pain distal to it. Spinal nerve quickly separates into ventral and dorsal rami.
- All these are enveloped by perineural fat which is contiguous with epineural fat. Catugo in 1764 described sciatica; for the first time it was to differentiate sciatic pain from dull aching pain.
  Andre was first to perceive disk as source of pain and Eslberg had described it for the first time.
  Mixter and Barr proposed that mechanical pressure exerted by nerve not causes pain.
  Genetics may also play role in inflammation is another factor. Especially phospholipase A2, IL-6, IL-8, PG B2.
  Corticosteroids most likely are related to decrease in PL-A2 and inflammation.
  Most patients are unsatisfied about counseling. 86% of chronic pain sufferers report inability to sleep. 60% have breakthrough pain one or more times daily. 14% are satisfied. 22% patients change physicians.

Facet joint pain:
- Unilateral or bilateral paravertebral pain there is increased pain on trunk rotation, stretching into full extension or on lateral bending.

In herniated disk:
- Radiating leg pain > back pain. Pain increase on sitting and leaning forward, coughing, sneezing and straining. Muscle spasm and loss of lordosis seen.
- Ipsilateral straight leg raising test: positive.

Myogenic/muscle related disease:
- Morning pain and muscle stiffness.
- Pain is unilateral or bilateral not midline.
- Pain extends into buttock and thigh region only. Pain is reduced with resisted prolonged muscle contraction and passive stretching of muscle.
- There is contralateral side pain with side bending.
- Even though macroscopically visible and histologically evident it was not always possible to demonstrate experimental annulus injuries by contrast enhanced MRI—spine 2002.
- Due to insensitivity of clinical tests sacroiliac induced pain requires diagnostic injections.
- Myelography is insensitive in lateral recess lesions.
  Cohen PM and Oaja PK had showed that use of historic and physical findings to diagnose lumbar zygapophyseal joint pain is not supportive.
Nociceptive pain generator model works for patients with mixed nociceptive/hypersensitization complexes. Radicular pain is single and subjective clinical feature that may be part of radiculopathy.

- Diskogenic low back pain which is pain at or above L5, loss of full range of motion and pain while rising from sitting (Yang et al, 2003) more centralized.
- Radicular pain may be due to disk herniation/inflammation or neural compression or vascular compromise.
- Chronic inflammation result in edema, wallerian degeneration and fibrotic changes in neural tissue.
- Radiculopathy is pathological disorder affecting the function of nerve roots.
- Depending on fibers affected there are features as sensory loss, motor loss, reflex loss, paresthesia and pain.
- Radicular pain is 95% due to disk herniation/foraminal stenosis.
- But in condition where somatic pain could occur due to epiduritis and perceived pathology is located ventrally in epidural space is not immediately assessible to conventional lumbar/caudal/epidural injection. Which delivers drugs to epidural space posteriorly/inferiorly.

Herniated nucleus prolapse is incipiently herniated disk at ventral surface of dural sac. If epiduritis is to be treated by epidural steroids, a transforaminal approach is most appropriate.

### RISK FACTORS FOR LOW BACK PAIN

- Age peak between 40–60 years, occupational factors, poor physical fitness, low social class, smoking.
- For chronicity
  - Pain intensity, interference with usual activities, with family and household activities, number of sites of pain.
  - Radicular pain is band like shooting, lancinating, electrical pain. Distal > proximal and cutaneous component. It is essential to differentiate it from psoas myofascial pain and sciatic nerve inflammation, extraforaminal spinal nerve entrapment.
  - Diagnosis by signs of nerve root tension by reproducing pain radiating to the patient’s buttock, thigh or calf pain by straight leg raising, only this type of pain should be treated. Precludes use of steroids for somatic referred pain. With somatic referred pain backache > leg pain deep seated and aching in quality constant and covers wider areas than narrow bands of radicular pain.
  - It is unusual for referred pain to extend distal to knee/elbow.
  - Signs of nerve root tension are negative. Straight leg raising may be restricted due to backpain and not due to reproduction of buttock or leg pain.
  - Only radicular pain is compatible with nerve root inflammation and for use of epidural steroids must be distinguished from somatic referred pain.
  - Neuropathic pain is usually described as burning, electric, tingling and shooting which cannot be controlled by traditional oral drugs management of neuropathic pain include other medications and multiple treatment modalities.
  - Nociceptive pain, is localized pain which is sharp, aching and throbbing, postoperative, pain associated with trauma and arthritic pain which usually responds to NSAIDs and opioids.
Chronic pain is multidimensional problem with multiple etiologies. Approach to pain management currently includes psychological behavioral, functional and interventional pain therapies.

- Origins of neural blockage and regional anesthesia dates back to 1884 - Koller reported the numbing effect of cocaine on tongue. It was used in ophthalmology, urology and general surgery in 1999.
- Caudal epidural injections were described in 1901(77-79); trigeminal alcohol blockade was reported by Schlossers in 1903.
- While Steindler and Luck in 1938 described applications for diagnostic interventional techniques.
- Steindler and Luck employed procaine hydrochloride injections for identifying sources of pain in low back pain disorders.
- Bogduck was responsible for our current understandings of clinical anatomy of spine.
- Hogan and Abram described several clinical situations including characteristic of chronic spinal pain, which are subjective and uncertain pathophysiology.
- Precision diagnostic blocks are used to define these clinical situations to determine pathophysiology of pain, site of nociception and pathway of afferent neural signals.
- Deyo and Weinstein reported that anatomic diagnosis is pivotal in low back pain and history, physical examination and imaging provide limited information.
- Anatomical diagnosis is possible in only 10% to 15% people.
- Following introduction of gate control theory, important observation made on descending modulation of pain perception. Brown and Mandl 1924—Block was used in management of visceral pain.
- Royle 1924 described blockade of sympathetic nerve supply to musculature of affected limbs in relieving deformity, contraction and spastic paralysis in Little’s disease.
- Swetlav described prolong pain relief by neurolytic injection of alcohol to paravertebral sympathetic nerves in treatment of severe pain.
- Doglotti injected absolute alcohol in subarachnoid space to produce chemical posterior rhizotomy.
- Sicard 1901 injected cocaine through sacral hiatus into epidural space for patient with severe sciatic pain.
- Cathelin also described caudal administration of local anesthesia not only for surgical procedures but also for relief of pain due to inoperable carcinoma of rectum.
- Pasquier and Ler in 1901 reported use of caudal epidural injection for relief of sciatic pain.
- In 1912, Kappis showed paravertebral somatic blocks for pain relief and surgery.
- In 1953, John Bonica stimulated interest in pain medicine.
- Vandam and Eckenhof described multidiskiplinary approach to relief of pain.
- In 1933, Waldomon and Winnie published book on interventional pain management.
IASP (International Association for Study of Pain) was established in 1974, the American Pain Society and American Chapter of IASP was established in 1977. American Academy of Pain Medicine was founded in 1920.

Established in 1988 World Society of Pain Clinics and World Institute of Pain also emerged in 1990.

American Society of Interventional Pain Physicians was founded in 1998.

Lippe—Physicians specializing in pain medicine may work in variety of setting and are competent to treat the entire range of painful disorders encountered in delivery of health care.

Pahol et al found that pain relief is particularly elusive for older women with disabling back and lower extremity problems similarly elderly patients also have same problems.

Bonica defined pain as pain when persist a month beyond the usual course of acute disease or reasonable time for any injury to heal that is associated with chronic pathological process that causes a continuous pain or pain at intervals for months or year.

Chronic pain syndrome is associated with major psychological and behavioral problems with or without a physical problem.

Recurrent pain is precursor of it. It is disproportional pain related to behavior. It is frequently seen in elderly.

Hendler et al found organic basis of pain in about 98% of patients. Subsequently Hendler and Kolodny estimated that incidence of psychogenic pain seen in 1:3000 patients.

For a structure to be implicated it should have been shown to be a source of pain in patients, proved using diagnostic technique of known reliability and validity.

Disk herniation, strained muscles or torn ligament have been attributed to most spinal pain either in upper extremities, upper and mid back or low back and lower extremities. Disorders of spinal joints which includes facet joints have implicated in 50% of pain.

The 2nd most common source is that of intervertebral disk due to disk degeneration.

Myofascial pain syndrome are not supported by prevalence of epidemiological data.

Nociceptive pain is caused by irritation of spinal nerve endings, it can be dull or sharp. Mild to severe neuropathic pain is caused by malfunction of nervous system. It occurs due to inflammatory agent, arthrosis, capsular tear cartilaginous degeneration.

Chronic pain is considered as persistent pain which is not ameable to routine pain control methods.

Halellus studied natural history of sciatica and found that at 4 weeks after a course of bedrest and bracing 93% had major improvements. Many studies showed that patients who underwent disk surgery might have better results than persons who did not have surgery at 1 year to 4 years but at 10 years there is no statistical difference in results, in this regards spine injections can be used.

Degenerative conditions other than disk disruption and facet arthritis may contributed to approximately 8% to 10% of spinal pain.
Wilberger described that time was required for mechanical deformation to cause this silent nerve compression.

About 90% of ruptured disk at L4–5 and L5 S1 level and 90% of patients with backpain and sciatica will recover without surgery, at least 50% within 6 weeks.

Sciatica might be associated with inflammation since steroid is used to relieve pain.

Bogduck postulates:
- Structure should have nerve supply.
- Be capable of causing pain.
- Susceptible for disease that are known to be painful.
- Source of pain in patient using diagnostic technique of known reliability and validity.
- Diagnostic block should have accessibility.
- Subjected to validity—criterion standard.

**Rationale** for therapeutic interventional techniques include, neural blockade in spine is based on:
- Source of chronic spinal pain namely disks and joints are accessible to neural blockade.
- Removal/correction of structural abnormalities of spine may fail to cure and may even worsen painful conditions.
- Degenerative processes of spine and origin of spinal pain are complex.
  - If a joint is determined to be source of pain long-term relief can be obtained by directing intervention at that joint.
  - Relief of pain is accepted criterion. Diagnostic blockade and ability to generate pain can be performed to test hypothesis that target structure, is a source of pain. Radiography confirms diagnosis but may be normal.
  - Clinical features and imaging/neuro-studies do not permit accurate analysis of causation of spinal pain in majority of patient in absence of disk herniation. Presence of organic origin of pain in 98% cases is mistakenly branded as psychogenic in origin.
  - Chronic low backache is diagnostic dilemma in 85% patient and disk and facet joint are accessible to neural block used for diagnosis.
  - Removal/correction of structural abnormality of spine may fail to cure and worsen the origin of spinal pain.

It is mandatory before any type of spinal block to have intravenous assess ECG, nasal O₂, noninvasive BP, fluoroscopy. If possible position patient in most procedures: prone with bolsters below trunk.

**Mechanism of action of local anesthetic:** Interrupt pain spasm cycle and reverberating nociceptor transmission, whereas steroids decrease inflammatory either by the synthesis/release of number of proinflammatory substances.

**Mechanism of action of steroids:** Membrane stabilization decrease neural peptide synthesis/action.

Blockage of phospholipase A2 decrease sensitization of dorsal horn neuron reversible LA effect

Local anesthesia prolong dampening of “c” fiber activity.

Clearing adhesion/exudates from vicinity of nerve root sleeve.
They are divided into:
(1) Diagnostic and (2) Therapeutic technique.
Diagnostic consist of selective nerve root block, facet joint blocks and provocative discography.
Therapeutic consist of facet joint injection, epidural injections and implantable therapies.

**Epidural Steroids (Figs 6.13 to 6.16 and Flow Charts 6.1 to 6.4)**

Epidural space is space between dural lining of spinal cord and nerve roots and osseoligamentous complex.
* Anteriorly, boundaries are vertebral body. Intervertebral disk and posterior longitudinal ligament.
* Posteriorly boundaries are thecal sac and ligamentum flavum.
* Spinal nerve exists within as intervertebral foramen bordered by vertebral body and disk and by facet joints superiorly and inferiorly pedicles of adjacent vertebrae.
* First epidural medication injected was cocaine with caudal approach for lumbago and sciatica, steroid was used for the first time in 1952.
* Definitive numbers are still not available regarding percentages of low back pain caused by disk herniation or facet joints.
* Meta-analysis for interlaminal injection carried out by Abdi et al used 12 randomized trials for transforaminal injections.
  Those with radiculopathy respond 3 times better than those without it. It does not work much in patients with backache.
* Nerve root inflammation always manifest as pain in limbs or around trunk wall.
* Studies have showed that epidural injections are excellent therapy for managing pain. About 30% of patients originally reported as candidate for surgery decided against surgery after injection.

![Fig. 6.13: Frontal view of spine anatomy](image)
Fig. 6.14: Side view of spine anatomy

Fig. 6.15: Surface landmarks of cervical and thoracic spine

Fig. 6.16: X-ray cervical spine in AP view showing spondylosis
Hirsch in 1963 described intra-articular injections for pain relief.

- Ryan and Taylor performed to intrathecal and epidural injection and obtained CSF samples the response of steroid in those patient with sciatica alone was far better than those with compressive symptoms and still better when duration of illness was short.
- About 75% of responders had higher than normal levels of proteins as compared to only 25% of nonresponders. So, are useful in stage of inflammation, hence best indicated in patients with radicular pain.

**Important Indication is Radicular Pain**

- Lancinating pain that travels down along the affected limb or around trunk wall.
- There is paresthesia in dermatomal distribution and deep seated pain in myotomal distribution. Pain extends distal to knee/elbow. In buttock, pain is deep seated cramp like aggravated on sitting and sometimes as paresthetic diskomfort.

  Epidural steroid injection intend to place steroid in epidural space. Epidural steroid is used for treatment and prognostic procedures. These injections were performed with blind approach, with advent of fluoroscopy. These injections in form of transformaminal blocks were given.

- Caudal epidural steroid involves introducing needle into epidural space through sacral hiatus. More amount of fluid needs to be given via this route.
- It is easy to perform and decrease risk of inadvertent dural puncture and inadvertent intrathecal injection. Local anesthetic has been shown to be convenient vehicle for introduction of steroid. It provides temporary relief of pain and onset of numbness in appropriate dermatome can be used as indication such that correct spinal segment has been infiltrated.

**Lumbar Epidural Steroids**

- Needle is passed through interlaminar space along midline through interspinous ligament needle must penetrate ligamentum flavum but fall short piercing the dural sac.
- Disadvantage is penetration of dural sac, so needle should be safely be advanced precisely into epidural space.
- Advantage directed closely to assumed site of pathology. Drug to being injected is delivered to its target. Lesser volume needs to be injected to assume that target site is reached.
- Results with small doses 2 ml are equivalent to those with large (10–45 ml) or intermediate volumes. Frequency—one to three injections some have used up to 6 months; if benefits perceived.

Efficacy of epidural steroids is controversial.

- Meta-analysis of epidural steroid injections revealed better treatment effect than placebo.
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- Bernan et al—epidural steroids does not cure the disease but provide prolonged pain relief.
- Abrahm and Flopwood et al—factors with poor outcome were also associated with poor results with epidural steroid.
  - These are low socioeconomic status, smoking, lack of employment, constant pain: Sleep disruption, nonradicular pain, delayed diagnosis, prolonged duration of pain; change in recreational activity, extreme values on psychological scales.

Lumbar epidural injections—large number of previous medicine for pain, high intake of medication, pain not necessarily increased by activity, increased by coughing, unemployment due to pain, pain that does not interfere with daily activities. Normal SLR before treatment.
- Age, duration of pain, pattern and frequency of pain intensity, results of physical examination, presence or absence of structural pathology. There is no relationship between emotional distress and outcome.
- Best results were found in patient with subacute/chronic leg pain with no prior neurological deficit and worst with those with motor or reflex abnormality. Negative myelogram is associated with good result.
- Cuckler et al did double blind, randomized study for disk herniation and stenosis and found no difference in result between placebo and single epidural injection.
- Patients with severe changes or with instability are least benefitted.
- After epidural steroid injections are successful in relieving pain, thereafter muscle strengthening physical therapy can be started. Epidural steroids are mainly used for diskogenic disease and other sources of pain local effects has been shown to last at least 3 at a desired level.
- Epidural steroids should be used in those patients in whom there is medical contraindication to certain oral analgesics and limited ability to engage in therapeutic exercises and those not fit for surgery.

Use of epidural steroid in conjunction with a rehabilitation program may play a very important role in the conservative management of patients with severe radicular pain, improving their quality of life and function.

Disadvantage of caudal entry.
1. Need for more volume of drug
2. Unrecognized placement of needle outside epidural space.

Advantage of Interlaminar Technique

- Many practitioners can do.
Disadvantages of Interlaminar Technique

- Blind injection
- Drug injected usually fails to reach
- Desired ventral epidural space is not reached
- Unable to use if postsurgery.
  So, fluoroscopy guided epidural injection should be preferred.

Caudal

- Advantage: Drug injected to ventral epidural space and less risk dural puncture.
- Disadvantage: Large volumes needed so low concentration of steroid used
  blind injection up to 30%, do not reach the target site.
- Post-injection there might be backache, postural headache (0.5–1% for lumbar
  interlaminar injections and 0.6% for caudal epidural injections), nausea,
  vomiting, dizziness, and vasovagal reaction. There might be bleeding along
  the trajectory of the injection, including in proximity to the nerve roots and/or
  the spinal cord.
- Infection is common in immunocompromised patients and this can include
  epidural abscess and meningitis. Nerve root injury has also been reported.
  Other rare complications include anterior cord syndrome, presumably
  resulting from the injection of particulate steroid into the artery of Adamkiewicz.
- There is the risk of spinal cord trauma if the operator performs direct injection
  into the spinal cord via an interlaminar approach (a risk that is essentially
  absent at the lower lumbar spine, since the spinal cord terminates at the level
  of L2).
  Cord trauma can also result from compression of the spinal cord from an
  epidural abscess or an epidural hematoma. These complications can be averted by
  using fluoroscopic guidance and contrast enhancement to avoid vascular uptake.
  (Vascular injection of particulate steroid matter is postulated to increase the risk
  of central nervous system infarct.)
  Critical arteries are found in the posterior aspect of the intervertebral
  neural foramina and that they may be vulnerable to injection or injury during
  transforaminal epidural steroid.
  Early use of epidural steroid injections (ESIs) can be considered in patients
  with severe radicular pain that does not respond even to opioid medication or in
  whom the pain is severely interfering with sleep habits and daily functioning.
  Early ESIs also carry theoretical benefit of controlling inflammation at early
  stage and of preventing permanent neural damage, such as nerve fibrosis from
  prolonged inflammatory process.
  Patients need to be re-evaluated postinjection for need of further injection up
  to 3–4 injections may be used for acute radicular pain syndromes.
  Epidural injections are used in various types of spinal pain. In lumbar canal
  stenosis, it had mixed results and good with caudal epidural steroids.
Epidural Steroid are Useful

- If leg pain retains more than 4 weeks, use 3 injections yearly.
- If disk height is maintained and age is less, conservative treatment is to be carried out.

Response Vary Greatly

- Hagen 2002, showed short-term effect 40%, no significant long-term effect.
- Wiesel 1995, showed that 82% had relief for 1 day, 50% for 2 weeks 16% for 2 months. 77% avoid surgery after injection.
- Curette 2002: There is neither significant functional benefit nor reduction in need for surgery.
- Epidural steroid are most effective in presence of acute nerve root inflammation. Patient is asked to grade the degree of pain in 0–10 scale before and intervals after subjective spinal injection.
- Epidural injections provide pain relief during recovery of injury with/without radiculopathy.
- Information obtained is helpful in confirming pain generators and source of patient diskomfort.
- Structural abnormality do not always cause pain and diagnostic injections can help to correlate abnormal imaging studies with associated pain.
- Epidural injection—pain relief during recovery of disk, nerve root injuries in patients during their level of physical activities, severe pain from acute disk. Therapeutic injection help to manage pain and may alleviate or if need for oral analgesics. Disadvantage—not well controlled studies.
- Many steroid injections were done without fluoroscopic guidance position of needle, and interpretation is doubtful. Several studies reported usefulness of transforaminal epidural corticosteroid to identify origin of specific root as pain generator.
- It appears to be most beneficial in patients with radicular pain, fluoroscopy guidance may be helpful, if bloody tap is obtained or if CSF is encountered procedure is to be aborted.
- Vijay Vad and Atul Bhat had shown that fluoroscopically guided transforaminal injection serve as important tool in nonsurgical management of lumbosacral radiculopathy with success rate of 84% as compared to 48% for group receiving trigger point injections.
- Everett et al showed that flushing as side effect of following lumbar transforaminal injection in up to 11% patients.
- Epidural steroids are less effective and multiple level injections are more effective than are single level was described by Tae kyu Park and Ji Hee Hong.
- For post-laminectomy patients, J Huang showed that transforaminal injections has better pain relief than caudal.
- Transforaminal injections are more effective than epidural.
- 150 patients were studied with < 30 SLRT, disk herniation on MRI at segments corresponding to radiculopathy, all those patients not relieved with this treatment were counceled for surgery.
Those given transforaminal steroids acheived complete relief of pain in 50% at end of one month (54% patients) against those treated with local anesthetic or transforaminal injection of saline (19%). Intramuscular steroids (21%) or intramuscular saline (13%). Relief of pain was proportional to improvement in disability.

Transforaminal epidural steroid for lumbosacral radiculopathy with a preganglionic approach is more effective than transforaminal epidural steroid and ganglionic approach at short-term follow-up—Hee Sum Jeong et al.

Jennig HS also showed similar results, transforaminal injections are superior to placebo as surgery sparing intervention and superior to interlaminal epidural steroid injection, ESI for radicular pain.

Transforaminal epidural steroid injection is not diagnostic.

Lumbar ESIs may be indicated for lumbar radicular pain associated with any of the following conditions:
1. Symptomatic acute or acute or chronic PID.
2. Spinal stenosis with radicular pain (central canal stenosis, foraminal and lateral recess stenosis)
3. Compression fracture of the lumbar spine with radicular pain
4. Facet or nerve root cyst with radicular pain.

Cervical epidural steroid have been used to treat following conditions:
1. Pain associated with acute disk herniation and radiculopathy
2. Postlaminectomy cervical pain
3. Cervical strain syndromes with associated myofascial pain.

Thoracic epidural steroids have been reported in the medical literature as treatment for pain associated with following conditions:
1. Acute thoracic disk pathology
2. Thoracic radicular pain secondary to disk herniations
3. Trauma
4. Degenerative scoliosis
5. Thoracic compression fracture.

Fluoroscopy should not be used in epidural injections for women who are pregnant.

Benefits of epidural steroids include relief of radicular pain and low back pain (with leg pain generally relieved more than back pain), facilitation of the ability to participate in physical therapy, improvement of quality of life, reduction of analgesic consumption, and improvement in the maintenance of work status.

Patients with symptoms of shorter duration have more sustained relief than those with chronic pain.

Patients with chronic back pain will generally have better response if they develop an acute radiculopathy.

Patients with factors favoring the use of epidural steroids also include those who have not had previous back surgery, who are not on workers’ compensation or those that require heavy manual work.
In a cross-sectional study design at a university spine center, 76 patients with sciatica were followed for a mean of 122 days after receiving transforaminal ESIs. Of these patients, 47% experienced improvement, 28% were unchanged, and 16% worsened.

If the radicular pain is from a recurrent herniated nucleus pulposus after lumbar spinal surgery, epidural steroid is beneficial.

In 2002, Lutz and colleagues reported a prospective randomized study comparing transforaminal lumbar epidural injection with lumbar paraspinal trigger-point injection. The success rate in the transforaminal injection group was 84%, compared with 48% in the saline group.

Botwin and colleagues demonstrated the efficacy of transforaminal epidural injection in their retrospective cohort study in patients with sciatica (caused by lumbar spinal stenosis). 34 patients who did not respond to nonsteroidal anti-inflammatory agents and oral analgesics received 1.9 injections (average). At 1 year, 75% of patients had greater than 50% pain reduction, 64% improved their walking duration, and 57% increased their standing tolerance. The injections can obviate the need for hospitalization and surgery in many patients.

Riew et al reported results from a prospective, randomized, double-blinded, controlled clinical trial on 55 patients with severe sciatica from spinal stenosis or lumbar disk herniations. These patients had not responded to 6 weeks of conservative treatment and were considered to be surgical candidates. The study demonstrated that only 23% of patients in the group that received lumbar epidural steroids needed surgery, while 67% of patients in the bupivacaine injection group underwent surgery.

There is more evidence favoring the use of transforaminal epidural steroids in the lumbar spine, compared with the cervical spine.

Barre et al reported that in patients with symptomatic lumbar spinal stenosis who received caudal epidural steroids. Long-term treatment success was seen in 35% of patients after a mean follow-up of 32 months.

Management of chronic pain from postlumbar laminectomy syndrome and spinal stenosis, the evidence is level II-1 or II-2 for caudal epidural injections.

Rhee et al found that those patients who underwent transforaminal injections had a 46% reduction in their pain score, and 10% needed surgery. In contrast, patients who had interlaminar injections had a 19% reduction in pain, and 25% required surgery.

Evidence is limited for blind interlaminar epidurals in managing lumbar pain, but there is short-term relief of pain secondary to disk herniation and radiculitis.

The delay in surgical decompression was not found to be detrimental to neurologic recovery at time of follow-up.

A prospective study by Rowlingson and Kirschenbaum described significant reduction in upper limb pain after cervical epidural steroids, transforaminal cervical epidural steroids are preferred over the interlaminar approach.

There occurs 30% to 40% of needle misplacements, such as needle tip placement outside the epidural space (including intravascular injection) and placement not at the presumed level of pathologic process.
• Negative aspiration of blood does not ensure a lack of vascular uptake. Similarly, in the cervical spine, vascular uptake injections occurred at a rate of nearly 20% even with the use of fluoroscopy (confirmed by contrast injection), via a transforaminal approach.
• Study involving 191 patients who underwent single-level lumbar transforaminal epidural injection, simultaneous epidural and vascular injections were found to be 8.9%.
• In a randomized study comparing the effectiveness of dexamethasone and triamcinolone used in cervical transforaminal epidural injection, found that at 4 weeks postinjection, both groups exhibited statistically and clinically significant improvement. Although the dexamethasone was slight less effective than triamcinolone.
  1. Epidural injections without fluoroscopy showed level II-2 evidence for short-term relief of pain of radiculitis utilizing blind interlaminar epidural steroid injection and level III for long-term disk herniation and radiculitis.
  2. Evidence is level III for short and long-term relief for spinal stenosis and diskogenic pain without radiculitis/disk herniation utilizing blind epidural injections.
  3. Evidence of effectiveness of epidural steroids in managing chronic spinal pain ranged from limited to strong is shown by Abdi S, Datta S.
  4. Evidence is limited in post-laminectomy syndrome and moderate for chronic low backache as described by Abdi S, Datta S.
• Bush and Hiller evaluated outcome and periradicular and epidural corticosteroid injection for cervical myelopathy, 93% obtained symptomatic relief for 7 months with average of 2.5 injections per patients to obtain adequate pain control.
• Rull et al evaluated 249 patients with lumbar root compression by means of epidural injection. Injectate include 10 ml of 0.25% bupivacaine and 80 mg of methylprednisolone. 63% with prolapsed intervertebral disk and 37% spinal stenosis, results were good in 66%, however, 78% of patients showed complete relief after a year.
• Cagler et al administered 80 mg of methylprednisolone in 25 patients at 2 weeks interval all had lumbar disk herniation. After first injection there was some response to treatment, after second, improvement continued. However, after third there was no change in objective or subjective pain relief.
• Fukasaki et al showed that interlaminar epidural steroid injections were not effective for spinal stenosis.
• Manchikanti described cost effectiveness of caudal epidural and transforaminal over interlaminar block.
• Strans studied evidence for overall effectiveness of interlaminar epidural steroid injection in managing chronic low backache is moderate for short-term relief and limited for long-term.
• Evidence for caudal epidural steroid is strong for short-term and moderate for long-term relief in treating chronic low back and radicular pain and limited in pain of postlumbar laminectomy syndrome.
• Evidence for interlaminar epidural steroid is strong for short-term and limited for long-term relief in managing lumbar radiculopathy whereas for cervical radiculopathy it is moderate.
• Evidence for transforaminal epidural steroid is strong for short-term and moderate for long-term improvement in managing lumbar nerve root pain whereas moderate for cervical.
• Evidence for transforaminal epidural injections/sensory nerve root block in preoperative evaluation of patients with negative/in conclusive imaging studies is moderate.
• For nerve root pain and pain secondary to lumbar post-laminectomy-percutaneous epidural adhesiolysis, spinal endoscopic adhesiolysis evidence is strong for short-term relief and moderate for long-term relief. Fluoroscopy and the use of contrast media are clearly necessary for cervical epidural injections.
• Validity of selective nerve root blocks is not established. No difference were found between lidocaine and bupivacaine.
• In cervical and thoracic epidural injections, a total of 3–5 ml may be used for ESIs employing the interlaminar approach. However, in cervical and thoracic transforaminal, clinicians generally use a total volume of only about 1.5–2 ml. Volume used for lumbar ESIs is slightly greater, generally being 6–10 ml for interlaminar ESIs, up to 20 ml for caudal ESIs, and 3–4 ml for transforaminal ESIs.

For epidural injections, many physicians prefer to use steroid preparations without preservatives. Single-dose vials of the corticosteroids, generally do not contain benzyl alcohol.

Becker and colleagues studied the use of autologous conditioned serum containing enriched IL-1 antagonist, for lumbar transforaminal epidural injections for radiculopathy. In comparison with triamcinolone 10 mg, the autologous conditioned serum injection had the same efficacy at 22-week follow-up with respect to pain reduction.
• It was first used by Robecchi and Capra, who injected steroid in spinal nerve root—earliest use of transforaminal route for epidural steroid.

Contraindications
• Altered anatomy, congenital anomalies or previous surgery.
• Patient with bleeding diathesis, fluid retention, adrenal function may be decreased in 2–3 weeks.

Unwilling patients, untreated infections, pregnancy, allergy to medications and dye, concurrent use of anticoagulant medications, systemic infections, immunosuppression, severe cardiovascular compromise, structural anomaly preventing access to epidural space.

Congenital anomalies/previous surgery may have altered normal anatomy of epidural space, neurological disease. Cauda equina syndrome, rapidly progressive neural deficit.
Price and colleagues (2000) have found that 35% of caudal and interlaminar injections performed without fluoroscopic guidance were not made in appropriate location. Difficulty may be encountered with placement of injectate below. For S1 nerve root there is risk of dural puncture. Post-puncture headache. Trauma of the needle to spinal cord. Anterospinal artery syndrome is complication of transforaminal epidural injections. Other complications—transient hypotension, severe paresthesia. Adrenal function may be suppressed for 2–3 weeks. Risks associated with inserting needle is spinal headache from dural puncture, bleeding, infection, allergic reaction and nerve damage and paralysis, steroids side effects may also be seen. Numbness/weakness must resolve within 8 hours in affected arm/leg. Steroids flush—flushing of face and chest that can last several days and accompanied by feeling of warmth on low grade increase in temperature, anxiety, trouble sleeping, changes in menstrual, temporary water retention, these side effects are mild and resolve with treatment. Kushnner and Olson reported retinal hemorrhage in 5 patient, with bleeding diathesis. Desio et al—facial flushing and erythema in patient after epidural steroid most serious was bacterial meningitis most others are transient. Rapid admission of large doses of steroid is also contraindicated. Most common problem is 25% rate of failure to place material. Intrathecal injection is a technical problem.

Complications
Related to improper needle placement
- Pain at injection site
- Nerve root, spinal cord injury
- Epidural hematoma, epidural abscess
- Meningitis
- Osteomyelitis
- Postural puncture headache.

General side effects:
- Weakness in lower extremity due to motor block
- Cardiac arrhythmias
- Seizure
- Hypertension
- Steroid side effect like transient weight gain, hyperglycemia, hypertension, facial flushing.
- Intra-arterial injections are associated with paraplegia reported in three cases. Spinal arachnoiditis is associated with epidural depo-medrol. These complications are caused by celestone in solution. Triamcinolone acetonide provides immediate
and long-term duration of action, soluble with no harmful preservative. Isotonic saline is only other injectable medium used frequently around spine.

**Useful Tips for Injection Technique**

1. Palpate bony landmarks and soft tissue, and mark site of injection.
2. Do thorough skin preparation.
3. Skin should be infiltrated and local anesthetic, with quick insertion of needle into joint causes minimum pain.
4. Most procedure should be done in supine positions.
5. There should be gap of at least 3 weeks preferably between the injections. If there is possibility of sepsis/septic arthritis or localized infection, do not inject.
6. Always aspirate before injection and always needle should be properly fitted to syringe. Warn patient of pain and counsel regarding post-procedure protocol.
7. Maximum benefit will be in initial days postinjection with better response to smaller joints. Large joints should not be injected simultaneously.
8. Not to inject into vessel/nerve/damage articular cartilage.
9. Strict asepsis with no touch technique and disposable needle and syringe are important.
10. Direct needle to target.
11. Confirm needle tip position with contrast.
12. Inject medication slowly.
13. Tissue feel soft tissue and bone.
14. Fluoroscopic visualization, AP later and oblique view, radiopaque contrast used for confirmation.
15. Tissue feel is important when in bone one is rest assured that it has not penetrated blood vessel/nervous tissue.
16. Water soluble contrast is benign even if injected intravascular and intrathecal, contrast will obscure further view for needle placement (Figs 6.17 to 6.20).
Fig. 6.18: Epidural block with epidural needle and loss of resistance technique

Fig. 6.19: Schematic diagram showing placement of needle in epidural space

Fig. 6.20: Syringes for epidural injection
Injection Techniques in Musculoskeletal Disorders

**Technique**
- Epidural needle 18–20 gauge 3–5 inch (Fig. 6.17)
- Spinal needle 22–25 gauge 5 inch short bevel needle
- 23 gauge 5 inch for giving local anesthetic
- 5 ml syringe
- 10 ml glass syringe (Fig. 6.20)
- Contrast
- Intravenous sedation can be used
- Medications corticosteroid preparation
- Volume: Interlaminar total volume 6–8 ml
- Transforaminal: Total dose per level 4 ml (both sides).

**Interlaminar Approach (Fig. 6.19)**
Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free, this opens up interlaminar space.
- Parts are painted and draped and local anesthesia is given after palpating interlaminar space and marking it.
- It position the needle one level below the site of suspected pathology due to cranial flow of solution in epidural space. There is no potential for deviation of needle toward the nondependent side.
- A 20 gauge epidural needle is advanced into lamina, using superior border of inferior lamina for support by walking off the lamina till ligamentum flavum is punctured. At this point there is loss of resistance. Carefully advance needle till loss of resistance is detected after entering epidural space. 1–2 cc of radio-contrast dye is injected to confirm the position (Fig. 6.18).
- Depth of insertion at point at which lamina is contacted, called critical depth. If done under C-arm guidance needle advanced to upper edge of lamina lateral to midline.
- After contact with lamina, needle is turned toward lamina and slowly advanced cephalad medially until contact is appreciated with ligamentum flavum. Once needle has engaged ligament, resistance to syringe pressure is tested.
- Loss of resistance to injection is tested intermittently as needle is slowly advanced through the ligamentum flavum. Indicates entry into epidural space is abrupt loss of resistance.
- When syringe disconnected nothing should flow from needle.
- If CSF leaks due to punctured thecal sac, procedure is abandoned.
- Aspiration should be done before injection. 1–3 ml of nonionic contrast medium should be injected. Pattern of dispersal of contrast medium confirms spread to epidural space.
- Once correct placement of needle is confirmed, steroid anesthetic mixture should be given.
**Note:** In interlaminar fluoroscopically guided injections, C-arm is oriented at 5–10 degree to open the interlaminar space. In the caudal approach one thing to be kept in mind is that needle should not be advance to higher than S2–S3 junction, if so, then there can be potential intrathecal spread/neural toxicity and post-procedure headache.

**Transforaminal Approach (Figs 6.12, 6.21 to 6.28 and Flow chart 6.5)**

Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free. Starting in AP position and confirm the position and level of vertebrae.

- Then move C-arm to 15–30 degree such that proper scotty dog picture can be visualized.

![Schematic diagram showing placement of needle in transforaminal block](image1)

**Fig. 6.21:** Schematic diagram showing placement of needle in transforaminal block

![Dye injected for transforaminal block](image2)

**Fig. 6.22:** Dye injected for transforaminal block
Fig. 6.23: Demarcation of flow of dye on nerve root

Fig. 6.24: Site of needle placement in transforaminal block in lateral view of lumbar spine

Fig. 6.25: Oblique view of lumbar spine showing site of needle placement in transforaminal block
Fig. 6.26: Dye injected for transforaminal block in lateral view of lumbar spine

Fig. 6.27: Dye injected for transforaminal block

Fig. 6.28: Position of needle in injection transforaminal block
Target is 6 clock position of pedicle.

Skin marking is done and skin and subcutaneous tissue is infiltrated with local anesthetic 2% lidocaine.

A 22–25 gauge 5 inch short bevel needle is then advanced under C-arm guidance towards target point. The tip of needle should be just below midpoint of pedicle and not cross the facet line (Figs 6.21, 6.24, 6.25 and 6.28).

In lateral view, needle tip should lie in the posterosuperior gradient of neural foramina. When needle is in optimal position radio-contrast dye is injected under C-arm guidance (Figs 6.22, 6.23, 6.26 and 6.27).

Contrast medium should not be allowed to reach next spinal nerve. 1 ml is sufficient to outline target nerve. If flow is in peripheral direction, the needle should be adjusted such that it is in central. For this, it is required that 2–3 ml syringe be used and injected slowly at 1 ml per 30 second approximately. There would be evoked pain.

Caution: No spread into dura or intravascular spread, once dye spread is confirmed, steroid anesthetic mixture is injected.

**TRANSFORAMINAL BLOCK**

Target point is base of pedicle above target nerve 5°–30° position on right and 6°–30º position on left, target point lies at apex of safe triangle. The needle is directed in an oblique approach to a target point on the apex of an imaginary triangle (the “safe triangle”), formed by a line tangential to the lower margin of pedicle, a line tangent to the lateral margin of the pedicle, and the hypotense passing obliquely inferiorly and laterally from the inferior medial corner of the pedicle. Advancement is made under lateral and anteroposterior views to provide a 3-dimensional spatial representation.

Needle tip directed into this triangle will be above and lateral to nerve will not incur damage to any other structure or significant risk of morbidity.

**Tips for Injection**

- Spinal needle is inserted through skin and back muscles along an oblique approach.
- Puncture point in oblique view of target foramen apex of superior articular process of ipsilateral segmental facet joint points directly upward towards target pedicle. Needle is passed just above and lateral to apex.
- Needle is advanced towards base of pedicle until further advance is arrested tip position should be confirmed on AP and lateral view.
- Once in correct position injections is made. Appropriate pattern of spread is important in which the contrast medium spreads ventral to nerve root sleeve curving upward and medially around pedicle, extending medially into epidural space. Peripherally the contrast medium outlines coarse of ventral ramus. Then steroid anesthetic mixture is injected.
In transforaminal block, key to needle placement is to see pedicle enface:

- Needle is directed toward undersurface of pedicle, since nerve roots are oriented obliquely it is better to be as close to undersurface of pedicle as possible.
- Needle is advanced to the posterior aspect of neural foramen and then advanced slowly anteriorly.
- Once needle is in midportion of neural foramen. AP view should be taken to show extension of contrast medium along perineural fat and into epidural space.
- Most authors believe that placement of needle at 6 O’clock position allows ample spread of therapeutic agent along nerve root sheath into epidural space without entering the thecal sac contacting dorsal root ganglion. Many place needle at 5 O’clock–7 O’clock depending on laterality, believe that this placement gives greater distribution to dorsal root ganglion. Lateral epidural space spread—anesthesia two levels at a time.

**CAUDAL APPROACH (FIGS 6.29 AND 6.30)**

Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free.

- Parts are painted with antiseptic solution and draped. With help of C-arm in lateral position useful to feel for sacral hiatus normally and then skin and subcutaneous tissues are anesthetized.
- Needle is advance cephalad towards sacral hiatus at 45° angle. Skin point of entry is such that it is more distal to the visible sacal hiatus and try to walk the needle into the sacrococcygeal ligament with slight resistance followed by loss of resistance. All these steps are carried out under C-arm visualization (Fig. 6.29).
- At this point radiocontrast dye is injected and appropriate spread is reconfirmed in hiatus with C-arm in lateral and AP position (Fig. 6.30).
• Negative aspiration is done before dye is injected to ensure that there is no blood/CSF aspirate.
• Nonionic contrast medium should be injected under C-arm guidance. Localized dense and poor spread of injected indicates needle is superficial.
• Lateral view is taken. If spread is not satisfactory needle should be repositioned and its location once again checked by free flow of contrast media cephalad.
• Volume of approximately 15 ml is used to reach to target segment and 10 ml to reach L5.

Caudal Epidural Steroids (Blinded)

Position: Prone target sacral hiatus palpated between cornu of sacrum. First find coccyx. Finger is then moved cephalad until 2 prominences are felt. Advance needle while infiltrating surrounding overlying tissue, the needle encounter superficial dorsal sacrococcygeal ligament covering hiatus, needle is advanced through ligament and 1–2 ml of lignocaine is injected 22 gauge spinal needle is advanced through sacral hiatus in sacral canal with bevel facing ventrally, once needle is perceived to have entered the sacral canal injectate is provided.

Studies show that interlaminar and epidural injections of steroids are as effective as local anesthetic alone.

Postprocedure
• Monitoring vital parameter is essential.
• It is instructed to apply ice packs if there is blushing and increasing pain, rest is advised and abstinence from driving for 24 hours and increased activity.
• Patient should inform if patient has persistent headache which worsens on sitting/fever/breathlessness/wheezing.
Cervical Epidural Steroid
- More safely done under C-arm control was first was given in 1972 through transfemoral approach.
- As there is no control of dispersal of drug into epidural space which depends on anatomy, injection volume and speed of injection and adding to it scarring may obstruct the passage into epidural space. This procedure involves injecting drug into epidural space surrounding the nerve root.
- Because of use of contrast medium and other control it is far more accurate.
  - Conservative treatment of low backache: Cognitive and behavior, NSAIDs, TENS, biofeedback, pain medicines, rehabilitative therapy second tier: systemic opioids, nerve blocks.
  - Spinal cord stimulation, cryoanalgesic—apply extreme cold to disrupt their ability to transit pain.
  - Radiofrequency lesioning—apply radiofrequency generated heat to nerves to disrupt pain transmission.
  - Intradiskal electrothermal therapy—apply heat to seal fissure and dehydrated disk.
  - Neuroablation destroy nerve tissue near source of pain. Implantable drug pump to CSF in intrathecal space surrounding spinal cord.
  - Neurostimulator—whole level electric impulses to interface with transmission of pain signals to brain.

FACET JOINT (FLOW CHARTS 6.1 TO 6.4)

Anatomy (Figs 6.12, 6.31 and 6.32)
Facet joint is encapsulated with thin fibrous layer that forms superior and inferior recesses that are filled with small synovial villi or fat pads approximately size of grain of rice. These become inflamed/entrapped between articular process producing pain.
- Facet when distended by contrast reproduces pain.
  - Articulating facets of C1, C2 are horizontal.
  - L2–3 are oblique from horizontal to anchor vertebrae.
  - Foramen transverse give passage to vertebral artery and vein and plexus of sympathetic nerves.
  - Thoracic vertebrae has articular facet that are directed backward and little lateralward and upward. In thoracic spine facet joints are in coronal plane permitting rotation and in lumbar spine they are in sagittal plane making rotation impossible.
  - Vertebral canal is average 17 mm for C3, 4 C6, 7 cord average diameter is 9.5 at C3 and 8 mm at C6.
  - Intervertebral canals are about 5–9 mm diameter.
- Facet joint is cause of pain in 15–45% patient with low backache and 36–67% of patients with neck pain.
Pathology: Synovitis of Facet Joint

- Gradual onset of swelling.
  
  Facet joint dysfunction follow conditions that forces joint beyond its normal restraints of capsule in synovitis, mechanical locking, osteoarthritis and painful entrapment.

Hemarthrosis

- Swelling within minutes, passive ROM is sluggish, painful.
  
  Manual therapy 120 days.
  
  May involve subluxation or dislocation of facet joint/degeneration of facet itself, exact pathophysiology is unclear.
  
  Chronic persistent neck pain is seen after initial episode of neck pain or whiplash injury.
  
  There was belief in facet joint as cause of pain since 1933 when Ghormley coined term facet syndrome.
  
  Innervation is derived from median branch of posterior primary ramus.
  
  Patient presents with nonspecific low back, hip and buttock pain which is deep and aching with pain radiating to posterior thigh, but not below knee, pain aggravated by rest and hyperextension, relieved by repeated motion, flattening of lumbar lordosis and point tenderness.
  
  Rees described radiofrequency denervation in 1971 and Shealy modified technique in 1975.
  
  Lau and Bogduck described the needle placement parallel to nerve root.
  
  Goldthwaite believed that lack of symmetry caused irregular movements and subsequent “backache”.
  
  Badgley—anatomy of L5S1 facet with inferior articular surfaces of L5 widened and more vertically oriented to S1 superior articular facets.
  
  Persol in 1930 described ligamentum flavum as contiguous structure with facet joint capsule.
  
  Jeffies 1988 suggested that multilevel innervation is probably one reason why facet joint pain frequently has broad referral pattern.
  
  Facets are most common source of chronic neck pain—Bomsley et al.
  
  Hirsch et al and Yomashika et al also reported rich innervation of facet joint altered interssegmental and segmental joint motion and postural distortions create aberrant traffic in nerve pathway.
  
  Bogduk 1993—used selective block for facet alone 23%, disk alone 20%, disk and facet 41%.
  
  Symptoms of facet joint syndrome in the lower back include:
  
  Pain or tenderness in lower back, that increases with twisting or arching the body, that moves to buttocks or back of thighs—this pain is usually a deep, dull ache, stiffness or difficulty with certain movements, such as standing up straight or getting up out of a chair. Joint injection/interruption of nerve supply is standard for diagnosis.
Symptoms of facet joint syndrome in neck include:
- Neck pain, shoulder pain, difficulty in rotating the head.
There are several possible causes of pain that originates in a facet joint.
- An injury and/or changes associated with aging might cause cartilage to wear away causing pain.
- Irritation of median branch of dorsal ramus nerves also lead to pain.
- Poor posture, causes malalignment, is a factor in development of pain from the facet joints. Trauma, inflammation, infection, and disk degeneration are other causes of facet joint pain.

**Delphi Experts Diagnostic Criteria for Facet Arthropathy**
- Positive response to facet joint injection.
- Localized unilateral low back pain.
- Positive medial branch block.
- Pain upon unilateral palpation of lumbar zygapophysial joints or transverse process.
- Lack of radiation features.
- Pain eased by flexion.
- Pain if defined, located above the knee.

**Arthritis of Facet Joint was Defined by James in 2007**
- Neuronal sensitization, neurogenic inflammation, injured facets heighten the pain sensitivity. Tight muscle secondarily brings facetal arthritic changes.
- Myofascial back pain is the 2nd most common cause Long et al 1996.
- Glial cells develop facilitatory circuits that magnify pain.
  
  In early degeneration there is subchondral sclerosis and cyst and osteophytes with joint space narrowing and medial angulation of posterior joint.

**In Disk Height Reduction**
- Facet joint capsule becomes lax
- Increase load transfer to facet joint
- Accelerate degeneration
- Joint subluxation hypertrophy osteophyte formation.
  
  Facet joint syndrome—synovial joint innervated by nerves, degenerate in concert with disk space.
  
  Pain and extension that include standing, working overhead use of sweeper, not aggregate/relieved by sitting, walking and lying down and morning stiffness.
  
  Stiffness in flexion and increase pain on extension especially lateral position, no sign of nerve root tension, irritation or compression.
  
  Ghormley was firstly declared that lumbar facet joints could be a source of back pain.
- Von Wijk and colleagues shown procedure on combined outcome measures but improved outcome was seen in selected individuals only.
- Intra-articular injection shows 46–75% of short-term pain relief, 20–36% following a single injection.
Sciatic type of symptoms in facetal arthritis alone has a lifetime incidence of between 15% and 40%.

Hildebrandt et al—Pathology causing pain is located in exact peripheral location.
- Local anesthesia totally abolishes sensory reflex of nerves and does not affect other nerves.
- Relief and attributed to block only.
- Relevance of nerve block in treatment and diagnosis of LBP is quality decisive.

Comparative LA blocks may not be implementable for intra-articular blocks for it is not known whether placement of LA in vascular environment effected its expected duration of action.

Positive Revel’s tests increase the likelihood to modest degree that pain is from facet joint and negativity reveal that likelihood of positive result from block is low.
- In old population there is 40% chance of facet joint pain.
  Facet joint block requires multilevel screening, i.e. negative predictive value and then screening. Single level at a time, if there is partial response to multilevel blocks in screening as facet pain may originate at multiple levels.
  Facet joints are innervated and capable of causing pain similar to that seen clinically and are source of pain in patient with chronic spinal pain. Controlled diagnostic facet joint block can be used to establish diagnosis of facet joint pain.
  Diagnostic accuracy of facet joint block is strong to be conclusive, based on compliance with criteria evaluating diagnostic test.
- False positive rate of pain relief in facet joint is 27–63% in cervical spine, 42–58% in thoracic and 17–50% in lumbar spine.
- Intra-articular injection of facet joint is more difficult; it might cause over distension of joint and may be associated with significant leakage of intra-articular injected fluid into epidural space and spillage over to the nerves.
- Median branch block is diagnostic procedure of choice if radiofrequency ablation is to be done.
  Radiofrequency neurotomy might be necessary to relieve pain and improve mobility. It is more effective than intra-articular block and requirements of steroid is much low.
  Accuracy is strong in diagnosis of lumbar and cervical facet joint pain and moderate in thoracic facet joint pain.
- Cook and Robinson et al 2008 described that, for facet joint pain single injection has 30% placebo response and reference standard is double fluoroscopically guided injections.
- Clinical features usually do not match with diagnostic blocks, age > 65 years, pain relieved in supine, lying, absence of pain aggravated by coughing/flexion/return from flexion/extension.
- Manchikanti et al 2000, showed sensitivity 13–17% and specificity 34–92% for diagnosis of facetal pathology by facet joint blocks.
- Correlation between instability and symptoms is uncertain and cannot be confirmed biomechanically.
Falco FJ Erhart S showed that evidence for diagnosis of cervical facet joint is level I or II-1 same is for therapeutic cervical medial branch. Block showed level II-1, evidence is lacking for intra-articular injection, level II-1 or II-2 for radiofrequency neuroablation.

Evidence for diagnosis of cervical facet joint pain with controlled comparative local anesthetic block is level I or II-1 and evidence for therapeutic block is also the same.

Multiple uncontrolled reports of percutaneous radiofrequency neurotomy in cervical spine are encouraging.

**Radiofrequency Techniques**

- Implies facet joint denervation—has temporary efficacy.
- In comparison with sham procedure, it is better than sham procedure shown by Van Kleef—Spine 1999.
- Anatomic study suggests that penetration into epidural space occurs following rupture of joint capsule. This provides explanation by which therapeutic results can be obtained if large volume is used.
- In intra-articular facet joint block there is short and long-term pain relief. Medial branch blocks evidence is moderate for short and long-term pain relief, for median branch neurotomy evidence is moderate. Short and long-term pain relief—Boswell et al. Relief is better for lumbar pain then cervical. Among diagnostic intervention accuracy of facet joint nerve block is strong in diagnosis of lumbar and cervical facet joint pain whereas moderate in diagnosis thoracic facet joint pain.
- Response in form of relief from low back pain varies from 52% to 79% at 3 months and 35% to 75% at 12 months.
- Facet joints and both disk and facet may be the cause of backache. No historic/physical examination finding can reliably predict response to diagnostic facet blocks. Patient could just have back pain not aggravated by movement, i.e. there are no objective findings except tenderness.
- Manchikanti and Vijay Singh followed up patients for 2 years. Therapeutic lumbar facet joint blocks show significant improvement in pain > 50%, functional improvement of > 40% for 82 of 100 patients with 5–6 doses and average relief for 19 weeks. In treatment of 438 patients prevalence of facet joint pain was 39% cervical spine, 34% in thoracic pain and 27% lumbar spine, false-positive with single block in cervical region is 45% in thoracic region 92% and lumbar region 45%.

Evidence for therapeutic intra-articular facet injection is moderate for short and long-term improvement and limited for cervical facet joint injection.

Manchikanti et al—Psychological factors failed to influence the diagnostic validity of facet block. No difference is noted diagnosing facet joint pain with LA alone or with mixture of sarapin/sarapin and depo-medrol.

Rees in 1970 described a technique of percutaneous denervation of painful facet joint.
Peterson et al showed that articular branch of lumbar facet joint were too small but parent trunks of articular branch proved suitable for this purpose.

- Evidence for efficacy of cervical and lumbar median branch block is moderate and median branch neurotomy is moderate.

For denervation for facet joint Bogduck angled the image intensifier about 10°–15° so that junction of the super-articular process and transverse process or junction of sacral ala and articular process of S1 is well seen. This allows electrode to be aligned parallel to medial branch with parallel orientation. A greater diameter of lesion has potential to ablate the implicated medial branch.

- Electrodes should not pass the posterior boundary of neural foramen.
- This ensures that entire nerve root and dorsal root ganglion are not ablated inadvertently.
- Unilateral or bilateral denervation typically are based on patient symptomatology.
- For medial branch 60 sec ablation with 80/6C is used.

Indications of facet joint block:
1. Focal tenderness over facet joint
2. Low backache without sciatica
3. Post-laminectomy
4. Recurrent disk disease
5. Persistent low backache after stable posterior lateral spinal fusion.

### INTRA-ARTICULAR LUMBAR FACET JOINT BLOCKS

(FIGS 6.31 TO 6.37)

**Performed Under Image Intensifier**

1. Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free.
2. Lower lumbar facet joints are obliquely oriented on average at about 45° to sagittal plane, so to visualize them. Patient has to be rotated and supported in an oblique, prone position, if C-arm is being use, X-ray beam is adjusted to bring joint space into view (Figs 6.12, 6.31 to 6.34).
3. Puncture site is infiltrated with local anesthesia intradermally 22–25 gauge, 90 mm (3.5 in) spinal needle is used to gain access to target joint. Double needle technique can also be used (Figs 6.34 and 6.35).
4. Needle is inserted through puncture site and directed under image intensifier guidance to target joint. It is worthwhile to rest the needle tip on either inferior or superior articular process of joint, for this establishes critical depth of insertion. Subsequently needle needs to be readjusted slightly to enter joint space and needs to be inserted just beyond initial depth (Fig. 6.35).
5. Target site for joint is midpoint of joint cavity. Needle is aimed at this site and operator then feels for loss of resistance changing from firm bony to soft that of tissue. Joint capsule, is pierced. Needle may penetrate deeper than original depth of articular process.
It becomes difficult if needle becomes embedded in articular cartilage. Needle should just penetrate capsule. In chondromalacia, rheumatoid arthritis, PV NS, entering on superior aspect of joint space deep through the capsule but peripheral to margins of articular cartilage is preferred. Less than 0.3 ml of contrast medium is used for confirmation with small syringe.
Injection Techniques in Musculoskeletal Disorders

Fig. 6.33: Inclination of C-arm on OT table

Fig. 6.34: Site of injection of facet joint block and median branch block

Fig. 6.35: Entry point and position of needle in facet joint injection
Figs 6.36A and B: Appearance of facet joint injection of dye

Fig. 6.37: Injection in facet joint with spillage of dye
In oblique view dumbbell shape is characteristic—slender tract of contrast medium outlines the intercartilaginous joint space and connect collection of contrast medium in superior and inferior subcapsular pockets (Fig. 6.36).

Lateral view—diskoid silhouette is outlined, if not in joint cavity then medium is seen to spread beyond vicinity of joint in a radiating pattern (extension between fibers of multifidus contrast media spread out of joint cavity through capsular foramina into extracapsular superior and inferior joint recesses) (Fig. 6.36).

Such extension is not sign of extravasation/joint rupture. It is due to lobulated smooth edge collection consistent in outline of the fat deposits in inferior and superior articular recesses. Not more than 1 ml of agent is injected. If difficulty is in entering the joint at its midpoint, needle is redirected to superior/inferior subcapsular pockets at superior and inferior pole of joint. The capsule is lax leaves subcapsular pockets.

Needle should be readjusted to upper and lower edge of joint, still contacting bone of articular process and then readjusted, so that it passes tangential to joint margin. Penetrate just enough to reach capsule.

Deep penetration risks spread to the subcapsular pocket and re-emerge from joint ventral to joint cavity.

### LUMBAR MEDIAN BRANCH BLOCK

Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free.

- With help of C-arm anteroposterior view is taken and level is confirmed.
- In AP fluoroscopic imaging, identify transverse process, e.g. L1 through L1, median block; penetrate the skin using 22 gauge or 25 gauge 3/3 inch spinal needle at and superior to target location.
- The C-arm is rotated in ipsilateral oblique fashion till scotty dog configuration is seen.
- For medial branches the target position for needle is at junction of base of transverse process and superior articular processes (contact is made with dorsal superior and medial aspect of base of transverse process so that needle rests against the periosteum) (Fig. 6.34).
- Under C-arm guidance needle is advanced to this target position. Once the needle hits bone at this point, it is walked off the bone. Needle position is then checked in lateral position 1 ml of radioconstant dye is injected to confirm that it is not intravascular. Steroid anesthetic mixture is then injected.
- Avoid penetrating the intermedialateral foramen with inadvertent paresthesia of nerve root on spread of injectate to epidural space.
- For intra-articular blocks similarly C-arm is rotated obliquely from 15–45 degree looking out for facet joint space (at the ear of scotty dog) and facet joint is identified after which needle is penetrated up to the middle portion of superior articular process as we reach the bone and hit the needle is slide medially and after resistance of facet joint capsule is felt there is sudden give
away. Care is to be taken to prevent inadvertent rupture of capsule by giving small amount of injectate (0.5 ml).

Procedure for blocking the medial nerve at L5 differs from the above since target point here is the superomedial aspect of sacral ala.

If one wants to block the facet joint L4–L5, medial branches to be blocked will be L3 and L4 which runs at the level of L4 and L5 transverse processes respectively.

Due to dual innervation, two medial branch blocks are required. At transverse process of L4 and L5 medial branch at transverse process of L5. S1 medial branch passes across sacral ala.

For S1 identify sacral ala rotate C-arm 15–20 degree ipsilateral obliquely to get exposure between ala and superior articular process of S1.

A 22–25 gauge, 3/2 inch spinal needle into osseoligaments landmarks rest spinal needle on periosteum and position the bevel of spinal needle medial and away from foramina. Inject 0.5 ml.

Procedure is simple, safe and easy; contrast medium is use with no reported ill effects.

**Postprocedural Care**

Fever, new onset weakness in extremities. Severe unrelieved pain, etc. is to be looked out for.

Patient should also keep follow-up to record their improvements in pain.

They should refrain from driving or operating heavy machinery on day of procedure.

**Complications**

Bleeding, infection, postprocedural radicular pain, the dural sac puncture and subsequent spinal headache, allergic reaction to medication possible vasovagal reactions.

Procedure related complications:
- Wrong level
- Transient in pain
- Transient radicular sensory change
- Dural puncture and headache
- Complication cervical: Puncture of vertebral artery
- Penetration of epidural and subarachnoid space and parasites and leakage of LA.
- Ataxia/unsteadiness
- Steroid weight gain, water retention, flushing, mood swings, insomnia.

**Myofascial Pain**

- Is referred pain that emanates from myofascial trigger point common sites piriformis muscles and quadratus lumborum.
- Piriformis-referred pain in sacroiliac area, posterior hip and upper 2/3rd of posterior thigh.
• Aching and deep pain which increase with activity or prolonged sitting with hip adducted, flexed, and internally rotated.
• Myofascial pain of quadratus lumborum—false sign of disk syndrome.
• Superficial fibers—sharp aching in low back; iliac crest, greater trochanter can extend to abdominal region. Deep fibers—SI joint or low buttock region.

**SACROILIAC JOINT BLOCK (FIG. 6.38 AND FLOW CHART 6.5)**

• Fluoroscopically guided articular blocks are preferred.
• One must eliminate lumbar spine and hip pain before considering SI joint pain. Sensitivity 94% and specificity 78% for 3 or more test.
• Sacroiliac joint pain might have placebo response to single blocks. Sacroiliac joint has diffuse innervation and nerves do not have fixed course, hence SI joint pain can be approached through SI joint block.
  It is innervated by ventral roots of sacral plexus anteriorly and posteriorly by dorsal rami of S1 to S4.
  When sacroiliac pain is unilateral it is better.
• With continued gluteal pain there is possibility of sacroiliac arthropathy which can mimic radicular symptoms or secondary myofascial pain.
  For SI intra-articular injection moderate for short-term relief and limited for long-term relief.
  Risk of infection, bleeding and allergic reaction should be discussed prior to the procedure.
• Radiofrequency neurotomy for SI joint pain is limited.

**Procedure**

Position: Prone with bolsters over lateral aspects of abdomen and flanks and abdomen hanging free.
In view, SI joint showing multiple shoe lines running parallel to each other. In semiparallel fashion more medial of these lines are formed by posterior margins. C-arm should be rotated usually to contralateral side so as to have all margins superimposed along caudal 1/3 of joint line.

Target point 1–2 mm cephalad of inferior end of joint line. After identifying target point local anesthetic is injected to skin and subcutaneous tissue to target point.

A 22–25 gauge curved tip needle is targeted to hit sacrum, felt hard locate the needle at joint line, needle first touches iliac or sacral side of joint, needle is then slide into the joint.

Once needle has struck the sacrum it should be withdrawn slightly and redirected towards joint space.

Entry into joint is recognized by loss of bony resistance as tip slips between sacrum and ilium.

Needle should not go too deep as it may emerge into presacral tissue anteriorly and injure artery.

Once in joint space intra-articular injection is confirmed with contrast medium. If needle is correctly positioned injection of 0.3 to 0.5 ml of contrast medium would be flowing cephalad in lateral view. Contrast medium densely outlines the joint margins.

Under fluoroscopic guidance steroid anesthetic mixture is injected.

**Discography**
- As disk height increases relative to vertebral body height so does ROM.
- Shape of disk varies per region.
- In thoracic spine, anterior and posterior have same measurement disk to vertebrae ratio is low so movement is limited in C spine. The disks are wedge shaped and are all anteriorly thick especially C5.
- First described by Lindblom in 1948 elaborated by Hirsch in 1948.
- Wise in 1957—fluoroscopically guided injection of radiopaque contrast into lumbar intervertebral disk is used as means of treatment planning for initial or repeat lumbar spine surgery. It was widely accepted as diagnostic aid by radiologist and neurosurgeons.
- Myelography provides little information regarding architecture and integrity of intervertebral disk.
- Diskogenic back pain is seen in internal disk disruption, degenerative disk disease and segmental instability.
- Olmasta (1995, Spine)—Disk herniation pain is due to inflammation, mechanical and vascular compression.
- Disk material is perceived as antigen, intense inflammatory response is put up.
- There is mechanical and local damage and intraneural ischemia. Biochemical effects of nuclear herniation are increase in phospholipase A, PGE2, cytokine, nitric oxide. In disk herniation and sciatica.
Neurofilament protein and S100 increase in CSF there is axonal and Schwan’s cell damage. But no reduction of NCV.

Vascular compromise at nucleus pulposus to nerve root may be the cause. Increase endoneural pressure, causing compartment syndrome. There may be decrease blood flow in dorsal root ganglion.

Discography would thus be useful in evaluation of both disk morphology and clinical relevance.

Central portion of disk is mucoid in structure and outer annulus fibrosis is composed of dense collagen, as disk degenerates the nucleus becomes less fluid in nature and vertical stress upon the disk are altered in their distribution due to which fissuring and tearing of annulus may occur and this will cause significant patient diskomfort, it may cause adjacent nerve root compression. Anatomic correlates of high intensity zones seen in MRI are strongly correlated with pain.

There may be multiple level of disk pathology. Pain, elicited or not, with individual disk space injection was an accurate reproducer of patient.

As disk height increases relative to vertebral body height so does ROM.

Shape of disk varies with region.

In thoracic spine, anterior and posterior disk heights are same. Disk to vertebrae height ratio is low so movement is limited in lumbar spine. The disks are wedge shaped and are all anteriorly thick especially L5.

Pain treatment could be directed only at level of concern and remaining disks though they may appear abnormal radiographically could be ignored.

During myelography mass effect on spinal nerves is all that could be visualized.

Entire outer 1/3 of annulus fibrosus and posterior longitudinal ligament and anterior aspect of thecal sac and nerve roots is innervated by nociceptive fibers.

These also extend peripherally along annulus at foraminal levels so can explain symptoms related to foraminal and lateral disk pathology, when there is no actual nerve root contact by disk material. So pain originating from process that involves outer 1/3 of annulus and posterior longitudinal ligament appears justified.

Whether pain elicited during discography that correlates with patients. Baseline pain is secondary to mechanical/biochemical/inflammatory/combination is less certain.

Injection of radiopaque contrast helps CT evaluation of intradiskal anatomy and MR imaging has also been proposed in this regard subtle annular tears and disk protrusions not visualized on radiography can be seen.

Eliciting the nature of pain during intradiskal injection is vital. Pain concordent with baseline pain is valuable in determining which levels to be injected.

Some believe that intradiskal pressure measurement during procedure may be of some value.

**Indication:** Those patients whose symptoms do not correlate with imaging by MR or CT myelography.
Provocation Discography (Figs 6.39 and 6.40)

- To determine if intervertebral disk is source of chronic spinal pain.

**Components**

- Sterile needle placement into the center of IVD.
- Radiocontrast instillation to provoke pain.
- Radiological assessment of disk morphology.
- Clinical assessment of intensity of evoked pain in related to baseline.

*Lumbar Discography Identifies Symptomatic and Pathological IVD's*

- Helpful in patient with low back or lower extremity pain
- Information obtained may not be sufficient to guide invasive treatment for diskogenic pain

Figs 6.39A and B: Fluoroscopically guided discography
CT discography is more accurate than myelography.
- Discography is superior to plain CT.
- Discography is as good as MRI.

Relationship of discography to outcomes including conservative management, minimally invasive surgery, and open procedures remains controversial.

Disk as source of pain (centralized) is an argument against surgery, described by Berthelof et al (2007). There is no substantial difference in outcomes of long-term nonoperative treatment and fusion was shown by Mirza and Deyo (2008).

Discography is usually asked for wherein need to avoid other joint block internal disk disruption (IDD) is most common cause of diskogenic pain 49% in those with abnormal disk on MRI. IDD is most likely if diskogenic pain is present, if disk stimulation shows painful disk at multilevel, then it should not be targeted for treatment.
Patient with bilateral back pain are highly unlikely to have bilateral SI joint pain and SI joint pain is always caudal to L5.

- Discography is often used to determine how many levels should be included in planned fusion in failed back syndrome in which patient have continued or worsened pain without imaging correlate or artifact due to metallic fixation.
- Discography is of value in visualizing disk anatomy and pathology whether disk at level of possible pseudoarthrosis or other abnormality are symptomatic. For intradiskal electrothermal therapy evidence is moderate in managing chronic diskogenic low back pain, for annuloplasty the evidence is limited.

**Technique**

Approach patient from contralateral side of pain. Patient is placed in comfortable position. To avoid confusing the patient with pain due to needle placement along adjacent nerve root.

With patient in prone position the X-ray beam is oblique to visualize end on at disk and visualize middle 1/3 of intervertebral disk space just anterior to superior articular process.

Coaxial system is utilized in with a 20 gauge introducer needle in outer margin of annulus fibrosus of disk and advance of 25 gauge needle through this outer needle and into middle 1/3 of disk using C-arm guidance.

Position of needle is confirmed by C-arm in both planer reviews.

Contrast is injected to view nucleus pulposus, annulus injections occur due to needle positioned too far ipsilaterally and anteriorly due to difficulty in placing needle from posterior osseous structures.

In severe degeneration distinction between nucleus pulposus and annulus is lost. This can be suspected and anticipated from preprocedure CT or MR.

Prior surgical fusion hardware or bone graft.

The L5-S1 disk level proves to be most challenging due to small osseous window between posterior elements and iliac crest. CT discography shows hamburger/cotton ball appearance of disk.

Nucleus injection can be confirmed by discography whereas annular injection provides detail disk anatomy but misleading and inaccurate pain evaluation.

Some annular tears are painful and this might cause confusion in diagnosis. Injection into a normal nucleus pulposus without annular tear/other disruption will not elicit pain. Not all abnormal appearing disks are symptomatic.

The amount of contrast injected and joint at which symptoms were reproduced is recorded discogram at a particular level is noted to be concordant or diskordant. Pressure at initiation of patient’s pain and maximum pressure measurement achieved during discogram is measured.

Pain at very low pressure during the injection are related to chemical pain and associated with annular tears resulting in decreased containment of injectate within the nucleus.

Risks associated with procedure are infection, hematoma, nerve injury, to avoid it smaller gauge needle is preferred.
Most feared complication is diskitis, use of preprocedural antibiotics and coaxial needle technique have decreased risk of infection.

- Diskitis—Persistent pain different from usual patient pain, fever, or abnormal laboratory studies as WBC count and C reactive protein. MRI is useful to rule out postprocedure diskitis and repeat CT also is valuable in evaluation of endplate osteomyelitis.
- Use of preprocedural antibiotics is controversial. Adherence to sterile technique is vital.
- Avoid sedation as it may hamper the pain provocation test and also avoid giving local anesthetic at outer annulus.

## VALUE OF DISCOGRAPHY

- There is lack of gold standard for assessment of a successful post-surgical outcome and role discography played in achieving that outcome.
- Procedure is safe and there are rare cases of infection, nerve injury and bleeding complications.
- Carnagee and Colleagues in 2004 showed that there is possibility of long-term nerve pain secondarily to injection.
- Some studies showed that discography is of clinical utility in surgical planning and used to determine operative levels. It is of value in preoperatively planning for spine surgery.
- There was considerable uncertainty over the validity of findings obtained by discography.
- First study was done by Holt in 1968 to challenge against discography.
- In 1990, Walsh presented results of discography in symptomatic and asymptomatic subjects when pressure of injection is controlled and low back pain is rare and pain does not occur generally the result of discography were proven to correlate with image of IV disk.
- North American Spine Society also released a review in 1991 that discography is valuable tool.
- Madan and colleagues found no significant difference in operative outcomes between groups who have undergone discography and those not.
- Diagnostic blockade of a structure with nerve supply which can generate pain can be performed to test hypothesis that target structure is source of patient’s pain.
- Testing hypothesis by provoking pain in any structure is unreliable criterion except provocative discography. Relief of pain is essential criterion in all except lumbar disks. When source of pain is at multiple sites then picture is confusing.
- Controlled block must be used, but due to ethical reasons it is prohibited.
- Placement of local anesthetic and different pain duration may not be effective in a vascular intra-articular environment, with medial branch blocks use of comparative local anesthetic blocks has been validated and found to be valid.
- Double blocks and comparative LA are required as diagnosis cannot be rendered reliable on basis of single blocs. Interval of 1 week should be used for most of intervention except for cancer pain can be to months or longer between each injection provided, at least 50% relief is obtained for 6 weeks.
Treat all regions at some time safely for all types of blocks. Number of injection per year should not exceed 4 and for sympathetic block 6/year.

For maintenance only as necessary maximum 6 times for LA with or without steroids per year and intervention like radiofrequency ablation 4 times per year.

For percutaneous nonendoscopic adhesiolysis with a 3-day protocol 2±3 interventions per year are recommended with 1 day protocol.

Blocks may be repeated after 6 weeks if need arises.

No more than 5 procedures should be carried out at a time in different regions and four in single region.

False positive rate may be as high as 40% in facet joint blocks.

**PROTOCOL FOR DIAGNOSTIC AND THERAPEUTIC SPINE INJECTIONS FOR BACKACHE (FLOW CHART 6.1 TO 6.4)**

- Diskogenic pain is confirmed within one step
- SI joint pain is excluded within one block or confirmed with 2 blocks
- In those whom SI joint pain is not suspected facet joint pain is excluded within one step, screening block or diagnosed within four steps, i.e. 1 screening block, one or two blocks at single level to pin point responsible joint and one confirmatory.

*Flow chart 6.1: Protocol for non-radicular pain*
Flow chart 6.2: Protocol for radicular pain

Majority of patients (approximately 40%) will have disk symptoms will undergo discography 60% remaining not all will require SI joint block but 30% will be positive and rest 30% will require it.

- In about 30% of cases SI joint pain will be diagnosed within one block plus a confirmatory block.
- In about 15% cases, investigation will exclude SI joint pain and facet joint pain within 2 blocks only, 15% of cases may require up to four or five blocks to pinpoint painful facet joint.
- On MRI first tumors/infection/metabolic disease are ruled out and if disk is normal in appearance discography should not be undertaken at first instance, also there is low yield of discography in normal looking disk on MRI, so in screening facet joints/SI joints are investigated and if both of these are negative return to considering disk again as source of pain.

If pain located to midline exclude disk pain.
Pain is bilateral exclude SI joint pain which is caudal to 15.
Revel’s test increases the likelihood to modest degree of affection of facet joint.
In young age, facet joints are less likely to be source of pain there is negative predictive value of multilevel facet joint block.
Flow chart 6.3: Protocol for chronic low back pain

Flow chart 6.4: Protocol for nonchronic neck pain
Single sitting both joints L4-L5.
Multiple joints blocked followed by one joint at a time.
If partial pain relief, then next level is blocked in confirmatory blocks facet joint pain is established in 5 steps.
1. Exclude SI joint pain
2. 1 screening block to implicate facet joint pain
3. 1 or 2 block to pinpoint the responsible joint
4. 1 to confirm response.

Manchikanti et al attributed 50% pain from facet joint and 5–10% spinal pain from disk degeneration other than spinal/facet pain, post-laminectomy—scar tissue, disestablished joints, recurrent or repeated disk herniation maximum dose of steroid is 210 mg per year in average person. Multiple injections demonstrate staircase phenomenon that plateaus after 3–4 interventions.

Implantable intrathecal drug administration systems indications: Control of chronic refractory, malignant and nonmalignant therapy.
Intervention should be safe accurate, painless, fast, ethical and wise.
For safety the needle tip position should be known before injecting it.
Particulate steroid should not be injected into artery.
In general, first position patent, then position the image intensifier, and focus on target.

- Percutaneous epidural endoscopic adhesiolysis for refractory low backache secondary to multitude of causes including postlaminectomy syndrome lumbar epidural fibrosis.

**Flow chart 6.5: Protocol for transforaminal, caudal epidural and facetal and SI joint block**
- Multilevel disk disruption.
- Multilevel degenerative arthritis.
- It is to be used in failure of conventional caudal and transforaminal epidural injections.
- Indication for disk injection and thermonucleolysis is a positive stimulation and analgesic response in cervical spine and positive disk stimulation in lumbar spine.

## FURTHER READING

207. Simon DL, Kunz RD, German JD, Zivkovich V. Allergic or pseudoallergic reaction following epidural steroid deposition and skin testing. Regional Anesth. 1989;253.
217. Stanton-Hicks M. Therapeutic caudal or epidural block for lower back or sciatic pain. JAMA. 1980;243:369.
237. Wiltse LL. Therapeutic caudal or epidural block for lower back or sciatic pain. JAMA. 1980;243:369.