# 10 Spinal Injections

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## Core Messages

- ✔ Morphological alterations in imaging studies of the spine are very common and it is difficult to differentiate symptomatic and asymptomatic alterations
- ✔ Spinal injections are used for diagnostic management of spinal pain to determine which morphological alteration could be a source of pain
- ✔ Spinal injection techniques are used for treatment of various spinal disorders as an adjunct to non-operative care
- ✔ Discography may be helpful in distinguishing asymptomatic from symptomatic disc degeneration (discogenic pain)
- ✔ Facet joint blocks are used as a diagnostic tool to differentiate symptomatic from asymptomatic facet joint alterations and as a therapeutic means to eliminate pain presumably arising from the facet joints (facet syndrome)
- ✔ Cervical and lumbar nerve root blocks as a diagnostic tool are helpful to verify the site and cause of the radiculopathy
- ✔ Cervical and lumbar nerve root blocks as a therapeutic tool are an effective treatment for the management of painful radiculopathy
- ✔ In cases of multilevel involvement or non-specific leg pain, epidural blocks may be used for pain alleviation
- ✔ Sacroiliac joint infiltration represents a diagnostic means to identify this joint as a source of buttock pain

## Rationale for Spinal Injections

Local spinal pain and radiculopathy are very common conditions which affect most of the population worldwide at some time in their lives. The lifetime prevalence ranges from 60 % to 90 % [26]. An initial treatment program consists of rest, oral medication with analgetic-anti-inflammatory agents, and physical therapy. But, in 10–20 % of these patients pain persists or recurs and quality of life is impaired, requiring further treatment. At this point evaluation for an anatomical etiology of pain is considered; the imaging studies of choice are usually plain radiographs and MRI.

Morphological alterations are common findings in asymptomatic individuals

The results of these tests must be correlated to the clinical investigation, because there is a **high prevalence of morphological alterations** in the spine in **asymptomatic individuals**, indicating that the correlation between pain and structural abnormality is weak [12].

There are only a few structural abnormalities which do not often occur in asymptomatic individuals [128], i.e.:

- nerve root compression
- large disc extrusion and sequestration
- moderate to severe facet joint alterations
- moderate to severe endplate changes

The diagnostic accuracy of imaging studies is limited in neck and back pain

However, the vast majority of patients with back and neck pain present with no or only minor structural alterations (e.g. disc protrusion, minor nerve root compression and mild facet joint osteoarthritis). The same alterations can be found with high prevalence in an asymptomatic population [5, 6, 12, 56]. The predictive value of MRI in diagnosing symptomatic disc alterations is therefore limited [12]. Spinal injection studies have been advocated to differentiate a symptomatic from an asymptomatic lesion because of the low positive predictive value of imaging studies [56, 74, 110].

The **rationale for spinal injections** is therefore either to:

- provoke spinal pain or
- eliminate spinal pain

The rationale of injection studies is to eliminate or provoke the patient's pain

which is presumably related to the target spinal structure. A large number of studies have accumulated in the literature which describe application, techniques and potential benefits. However, the lack of a clear understanding of the pain pathogenesis and therefore a missing gold standard makes it difficult to decide on the diagnostic impact of these injections [11, 96].

Injection studies can have a therapeutic effect

The frequent use of spinal injections as a **diagnostic tool** has indicated that these injections may also have a therapeutic value. The second rationale is to use spinal injections to **support non-operative treatment** in patients suffering from nerve root compromise, spinal stenosis, or facet joint osteoarthritis. However, debate continues whether the rationale for the use of spinal injections is evidence based [80, 119, 124]. Despite the widespread use of these spinal injections, their application is widely based on anecdotal experience and at best is evidence enhanced but definitely is not evidence based.

## Lumbar and Cervical Nerve Root Blocks

**Selective nerve root blocks** (SNRBs) were first described by Macnab [67] and coworkers in 1971 as a diagnostic test for the evaluation of patients with negative imaging studies and clinical findings of nerve root irritation.

Radiculopathy is caused by a combination of mechanical compression and inflammation

The high prevalence of asymptomatic disc herniations [6, 12, 13, 56] is often a prompt for a verification of the morphological correlate for equivocal radicular pain. **Pain pathogenesis** in cases with nerve root compromise is caused not only by a mechanical compression but also by a chemical irritation due to pro-inflammatory cytokines [17, 18, 83–85]. The rationale for nerve root blocks is therefore to tackle the **inflammatory component** of the nerve root compromise [83–85]. The peri-radicular foraminal nerve root block is always performed under image intensifier control, allowing for a direct application of the anti-inflammatory agent to the target nerve root [87]. The objective of a therapeutic selective nerve root block is not to cure the patient by interfering with pathogenetic factors that are responsible for sciatica but rather to provide temporary relief from peak pain during the time required for spontaneous resolution of radiculopathy.

Nerve root blocks tackle the inflammatory component of radiculopathy

### Indications

Indications for selective nerve root blocks are applied for a diagnostic as well as a therapeutic purpose (Table 1).

**Table 1.** Indications for selective nerve root blocks

**Diagnostic indications**
- equivocal radicular leg or arm pain
- discrepancy between the morphological alterations and the patient's symptoms
- multiple nerve root involvement
- abnormalities related to a failed back surgery syndrome

**Therapeutic indications**
- acute radicular leg or arm pain in the absence of major neurological deficits
- subacute radiculopathy not responsive to non-operative care
- mild to moderate foraminal stenosis

## Technique

Perineural infiltrations are performed at the foraminal exit

It must be stressed that injections into the nerve root must be avoided because of the potential risk of permanent nerve root damage. The injection which is recommended is a perineural infiltration. The treatment agent used for this procedure varies between studies. Most authors use a mixture of 2 ml 0.25% bupivacaine and 40 mg methylprednisolone [57, 81, 91]. Others have used 1.5 ml 2% lidocaine with 9 mg betamethasone acetate [65]. There is no study to suggest which is best in terms of treatment outcome. We report here the techniques which work best in our hands.

### Lumbar Nerve Root Blocks

Lumbar nerve root blocks are done under fluoroscopy control

The standard technique is an **outpatient procedure** without premedication which can be done either in a radiology suite or an operating theater. The patients lie prone, with the injected side elevated approximately at a 30° angle. The final degree of rotation is determined with **fluoroscopy**. The goal of positioning is to allow for a perpendicular needle tract towards the classic injection site underneath the pedicle. The so-called **safe triangle** is defined by the pedicle superiorly, the lateral border of the vertebral body laterally, and the outer margin of the spinal nerve medially (Fig. 1). After skin disinfection, a local anesthetic is administered using a 25-gauge needle. With fluoroscopic guidance, a 22-gauge needle is then advanced through a shorter 18-gauge needle to the region of the safe triangle. For accessing the L5 and S1 nerve root the standardized technique is adapted slightly. For the L5 root, the needle usually has to be tilted in a craniocaudal direction in order to bypass the iliac wing. The **S1 infiltration** is performed through the dorsal S1 foramen. The needle position is checked with biplanar fluoroscopy, followed by an injection of 0.3 ml of contrast material. Anteroposterior spot radiographs are obtained for the documentation of the contrast material distribution. Two milliliters of 0.2% ropivacaine and 40 mg of triamcinolone are slowly injected.

Pain and neurology must be assessed prior to and after the block

After the procedure, the subjective perception of **numbness** in the dermatome is regarded as a quality control for a correct injection and should be noted. Sometimes **muscle weakness** occurs in accordance with the innervation pattern. **Pain relief** should be assessed prior to and 15–30 min after the injection using a visual analogue scale.

### Cervical Nerve Root Blocks

Cervical nerve root blocks should be done under CT fluoroscopic guidance

We recommend performing cervical foraminal injections with CT fluoroscopic guidance to improve safety (Fig. 2). Misplacement of the needle can have deleterious consequences. The patient lies supine, with the head turned to the contralateral side. After skin disinfection and administration of local anesthetics, a


**Figure 1. Lumbar nerve root block**

The needle is positioned in the so-called "safe triangle" directly underneath the pedicle but superior and lateral to the existing nerve root. The image shows correct needle placement and an indirect radiculography.

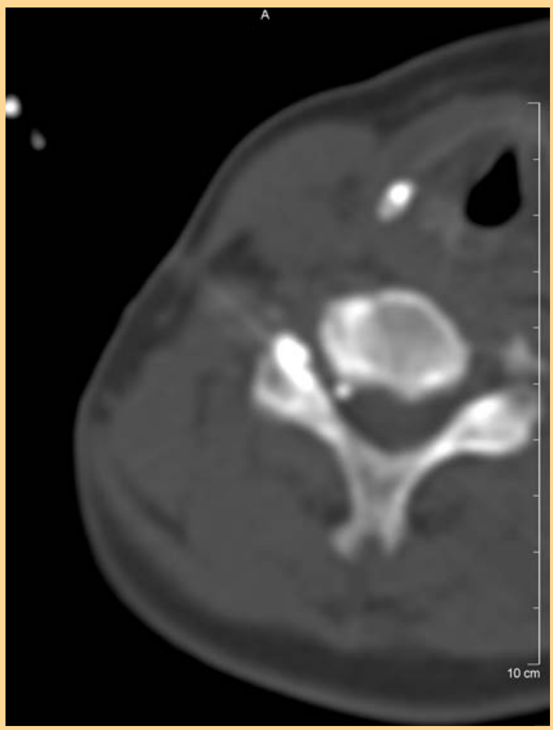


**Figure 2. Cervical nerve root block**

CT guidance for cervical facet nerve root blocks is preferred because of the spatial relationships to the spinal cord to avoid neurological damage. The image shows a CT-guided nerve root block after application of contrast medium at the foramen intervertebrale C5/6.

22-gauge needle is introduced under fluoroscopic guidance by using a lateral or slightly anterolateral approach dorsal to the large cervical vessels. The needle is aimed at the posterior border of the neural foramen, dorsal to the vertebral artery. Initially, 0.3 ml of iopamidol is injected to verify the correct position of the needle tip. The intraforaminal distribution of the contrast material is documented with a single CT-fluoroscopic scan. A maximum of 40 mg of crystalloid corticosteroid suspension-triamcinolone plus 1 ml of 0.2 % ropivacaine is slowly injected. Pain relief should be assessed prior to and 15 – 30 min after the injection using a visual analogue scale.

## Complications

Complications associated with nerve root blocks are rare. However, the following **complications** have been reported [14, 52]:

Complications are rare after lumbar nerve root blocks

- transient non-positional headache (3.1 %)
- increased backache (2.4 %)
- increased leg pain (0.6 %)
- facial flushing (1.2 %)
- vasovagal reaction (0.3 %)
- hypertension (0.3 %)
- increased blood sugar (0.3 %)
- dural puncture

Houten et al. [51] presented three cases with persisting paraparesis and paraplegia which occurred immediately after administration of a **lumbar nerve root block**. In each instance, penetration of the dura was not thought to have occurred. The sudden onset of neurological deficit and the imaging changes pointed to a vascular causation. A devastating complication reported by Rozin et al. [95] described a case of a death associated with a C7 **cervical nerve root block** performed in a 44-year-old female. The patient died of massive cerebral edema secondary to the dissection of the left vertebral artery and subsequent thrombosis due to the perforation of that artery by a 25-gauge spinal needle. Brouwers et al. [15] described a case of a 48-year-old man who underwent diagnostic C6 nerve root blockade. Immediately following the uneventful procedure he developed an MRI-proven fatal cervical spinal cord infarction. The authors suggest that the infarction resulted from an impaired perfusion of the major feeding anterior radicular artery of the spinal cord.

Cervical nerve root blocks may result in spinal cord injury

## Diagnostic and Therapeutic Efficacy

Selective nerve root blocks are useful tools in the diagnosis of radicular pain in atypical presentation, especially when the clinical presentation does not correlate with imaging study. This can be the case when the root is compressed only under load. Diagnostic help is also provided in cases of multilevel disease. The therapeutic effect lies mainly in an **immediate pain reduction** (Table 2). If there is an inflammatory component, pain resolution will last for a few weeks and could be permanent because of the benign natural course of this disease.

Nerve root blocks allow for a rapid pain reduction

### Lumbar Nerve Root Blocks

Selective lumbar nerve root blocks were originally used with contrast agent and lidocaine and aimed to differentiate different sources of leg pain in an equivocal clinical situation [67]. Frequently, it is not possible to localize exactly the compromised nerve root either by clinical neurological examination or by imaging

**Table 2.** Therapeutic efficacy of nerve root injections

| Author/year | Study design | Technique | Patients | Indication | Follow-up | Outcome |
|---|---|---|---|---|---|---|
| Weiner et al. 1997 [126] | cohort prospective single blinded, uncontrolled | lumbar foraminal injection | 30 | lumbar radiculopathy | 3, 4 y | 78.5 % improved at 3, 4 y |
| Lutz et al. 1998 [65] | open study prospective blinded, uncontrolled | lumbar transforaminal | 69 | sciatica due to disc herniation | 80 w | 75 % positive outcome |
| Riew et al. 2000 [91] | prospective, randomized, double blind | nerve root injection bupivacaine with/without betamethasone | 28 vs 27 | lumbar radicular pain | 13 – 28 m | 20 improved vs 9, 8 vs 18 had operation (significant difference) |
| Kolsi et al. 2000 [60] | prospective, controlled double blind | transforaminal vs interspinous | 17 vs 13 | sciatica | 7 and 28 d | significant benefit in both, mean pain score fell from 70 to 26 vs 63 to 23, no differences |
| Pfirrmann et al. 2001 [86] | cohort, prospective | lumbar SNRB | 36 | sciatica | 2 w | pain relief in 86 % |
| Karppinen et al. 2001 [57] | randomized, double blind | lumbar periradicular steroid infiltration vs saline | 160 | unilateral sciatic pain for 1 – 6 months | 2 w, 3 and 6 m, 1 y | after 2 w significant benefit for leg pain, spinal mobility and patient satisfaction in steroid group, 65 % improvement in both groups late |
| Narozny et al. 2001 [79] | cohort, retrospective | lumbar, periradicular steroid + bupivacaine | 30 | monoradicular leg pain with unequivocal morphological correlate | immediate (1 – 4 d), 2 – 3 w, and mean 16 m | 87 % rapid pain regression, 60 % permanent pain resolution |
| Vad et al. 2002 [119] | prospective, randomized not blinded | transforaminal vs trigger points with saline | 25 vs 23 | lumbosacral radiculopathy due to HNP | 16 m | 84 % improvement (mean Roland Morris score, VAS, finger floor distance, patient satisfaction) in transforaminal vs 48 % in trigger points |
| Thomas et al. 2003 [117] | randomized, double blind | transforaminal vs interspinous epidural | 16 vs 15 | discal radicular pain | 6 and 30 d, 6 m | significantly better pain relief on Dallas pain scale in the transforaminal group at all end points |
| Ng et al. 2004 [81] | cohort, prospective | lumbar selective nerve root block | 55 LDH, 62 stenosis | unilateral radicular pain | 6 and 12 w | no statistical difference in VAS improvement 57 % vs 37 %, statistically better outcome in functional outcome for LDH |

Note: d = day, w = week, m = months

Postinjection pain relief is indicative of the involvement of the target nerve root

studies. This is particularly valid for multilevel nerve root compromise shown by MRI. Numerous studies [28, 36, 112, 122, 126, 132] have shown that nerve root blocks are helpful in cases where this close correlation is lacking. In the case of a positive response (i.e. resolution of leg pain), the nerve root block allows the diagnosis of the affected nerve root with a sensitivity of 100 % in cases with disc protrusions and with a positive predictive value of 75 – 95 % in cases of foraminal stenosis [28, 122]. Only a few controlled studies analyzing the therapeutic efficacy of selective nerve root blocks have been published (Table 2).

### Cervical Nerve Root Blocks

Similarly to the lumbar spine, cervical disc herniation or spondylosis can cause discogenic or foraminal osseous nerve root compression, resulting in cervical radiculopathy with or without neurological compromise. However, there are only a few studies regarding selective cervical nerve root blocks. In 60 patients with cervical radiculopathy, Strobel et al. [114] investigated whether magnetic resonance imaging findings can predict pain relief after CT-guided cervical root nerve block. The mean percentage of pain reduction (VAS) was 46%. Patients with foraminal disc herniation, **foraminal nerve root compromise**, and no spinal canal stenosis appear to have the best pain relief after this procedure.

Patients with foraminal compromise appear to have the best outcome

Berger et al. [4] performed CT-guided foraminal injections and reported effective long term pain relief in 11 of 18 patients with cervical radiculopathy (61%). In a retrospective study, Slipman et al. [107] investigated fluoroscopically guided cervical nerve root block in 20 patients with cervical spondylotic radicular pain. An overall good or excellent result was observed in 12 (60%) patients. The authors concluded that there is a role for SNRB in the treatment of atraumatic cervical spondylotic radicular pain.

In a prospective cohort study presented by Vallee et al. [121], 30 patients with cervical radicular pain of more than 2 months duration due to foraminal stenosis were given transforaminal injection of steroids. After 3 months, 29% of patients had complete pain resolution. They observed complete or more than 75% pain relief in 53% of patients at 6 months. After 12 months 20% had complete pain relief.

## Epidural and Caudal Blocks

Treatment of cervical and lumbar pain syndromes via an epidural injection of corticosteroids was first described in 1952 [92]. Cervical epidural corticosteroid injection was first mentioned in 1972 by Winnie [133] but has not found widespread application, probably because of the fear of complications. The rationale for epidural injections is comparable to those for nerve root blocks and aims to diminish the inflammatory component of a neural compromise. Epidural injections include a variety of injection techniques such as caudal (sacral), interlaminar lumbar and cervicothoracic. In contrast to the selective nerve root blocks, epidural steroid injections have the **drawback** that the pharmacological agent has to diffuse to the site of inflammation and there is no guarantee that it does so.

Multisegmental neural compromise may be treated with epidural blocks

The spatial pharmacological effect is difficult to control

### Indications

In cases with multilevel involvement or non-specific leg pain the epidural route has some advantages compared to selective nerve root blocks (**Table 3**).

**Table 3.** Indications for epidural/caudal steroid injections

- multilevel nerve root compromise
- equivocal cases with abnormal radicular leg pain
- central spinal stenosis

## Technique

### Lumbar Blocks

Steroid injections are possible via the epidural as well as the sacral route

The preferred level is one level above the target level. Other authors favor the level which corresponds to the segment of origin of the patient's symptoms. One or two percent anesthetic agent is injected to anesthetize the needle track. Using an interlaminar approach, a 22- or 25-gauge spinal needle is advanced between the spinous processes of the target level. Aiming at the upper edge of the lower lamina, the needle is inserted into the posterior epidural space with or without fluoroscopic control depending on one's personal experience with this technique. The location is confirmed using a small amount of contrast material.

### Caudal Epidural Blocks

The correct needle position should be documented by contrast agent administration

Alternatively a caudal approach placing the needle into the sacral hiatus is used. This technique is relatively easy to perform. However, as the sacral epidural space must be filled before solutions can be delivered into the target region, large volumes are required. Furthermore, it has been shown that the sacral epidural space can be blocked in a considerable proportion of patients [33]. It is strongly recommended to use a small amount of contrast medium to ensure that the steroid is applied in the epidural space. Employing **contrast agents**, the specialist may document whether the drug has reached the potential pain generator. Patients are asked to rate their pain before and after the procedure on a visual analogue scale. However, the steroid injection may take several days to be effective. Therefore, the assessment of the pain level directly after the injection is unreasonable.

### Cervicothoracic Blocks

Do not inject anesthetic agents in cervical blocks

The patient is placed prone and the skin is draped in sterile fashion. The C-arm fluoroscopic axis is angled 10° to 15° off midline and caudal for this alignment. The entry point is 1–2 cm from the midline, slightly caudal to the interlaminar gap, normally at C7/T1 or C6/7. After local anesthesia of the skin a spinal needle (22 or 25 gauge) is advanced with cephalad angulation into the dorsal midline epidural space. After confirmation of the right position the steroid injection is performed. Anesthetic agent is not injected into the cervicothoracic space to avoid the risk of a high cervical anesthesia.

## Complications

Although complications are possible with any invasive procedure, reports on series of thousands of lumbosacral epidural steroid injections reveal that they are relatively safe. However, **serious complications** such as epidural abscess, arachnoiditis, epidural hematoma, cerebrospinal fluid fistula, paraparesis and death have been reported [14, 15, 30, 51, 131].

## Therapeutic Efficacy

The therapeutic effect is often only short term

Most reports in the literature are of uncontrolled, retrospective observational studies (Table 4). Despite major methodological flaws the average success rate of epidural injections is in the order of 70% [59]. The **efficacy of epidural steroid blocks** is **short term** and minor in comparison to selective infiltration due to lack of a determined target.

**Table 4.** Therapeutic efficacy of epidural injections

| Author/ year | Study design | Technique | Indication | Patients | Follow-up | Outcome |
|---|---|---|---|---|---|---|
| Beliveau 1971 [3] | controlled, randomized | epidural caudal procaine + steroid vs procaine | sciatica | 24 vs 24 | 1 w, 3 m | no significant improvement 18 vs 16 patients |
| Dilke et al. 1973 [35] | controlled, prospective randomized, double blind | lumbar translaminar saline + steroid vs saline alone | unilateral sciatica | 44 vs 38 | 3 m | significantly less pain in steroid group (40 improved vs 28) |
| Snoek et al. 1977 [111] | controlled, prospective randomized, double blind | lumbar translaminar steroid vs saline | sciatica due to nerve root compression | 27 vs 24 | 3 d | no difference LBP (33 vs 25 %), radicular pain (26 vs 13 %), sciatic nerve stretch (36 vs 25 %) |
| Yates 1978 [135] | randomized, double-blind, patient acted as his own control | steroid with/without lignocaine vs saline with/without lignocaine, each patient 4 injections | low back pain, sciatica | 150 injections, analysis of 49 injections in 20 consecutive patients | immediately, after 30 min | steroid groups better than without steroid in straight leg raising |
| Klenerman et al. 1985 [58] | controlled, prospective randomized, double blind | lumbar translaminar saline + steroid vs saline/bupivacaine | sciatica | 19 vs 16 | 2 m | benefit 15 vs 11 pts., no significant difference |
| Cuckler et al. 1985 [34] | controlled, prospective randomized, double blind | lumbar translaminar steroid + procaine vs saline + procaine | clinical and radiographic nerve root compression | 42 vs 31 | 1 d and 13 – 30 m | early improvement 42 % vs 44 %, no significant difference in both groups |
| Matthews et al. 1987 [71] | controlled, prospective randomized, double blind | epidural caudal steroid + bupivacaine vs lignocaine subcutaneous | sciatica | 23 vs 34 | 1, 3 m, 1 y | after 1 m no significant difference (67 vs 56 %), after 3 m steroid group significantly better |
| Ridley et al. 1988 [90] | controlled, prospective randomized, double blind | lumbar translaminar saline + steroid vs saline | low back pain + sciatica | 19 vs 16 | 2 w, 6 m | after 2 w significant pain relief in steroid group (90 % vs 19), late none |
| Glynn et al. 1988 [45] | randomized, double blind | epidural bupivacaine + morphine vs bupivacaine + clonidine | low back pain | 10 vs 10 | 3 h | no statistical difference |
| Rocco et al. 1989 [93] | randomized, double blind | epidural translaminar lignocaine + steroid vs lignocaine + steroid + morphine, vs lignocaine + morphine | low back pain | 8 vs 7 vs 7 | 1, 6 m | after 1 m mean VAS improvement 0.6 vs –0.6 vs 0.4, after 6 m improved 1 pt. vs 0 vs 0 |
| Bush et al. 1991 [19] | prospective randomized, double blind | caudal epidural steroid + procaine vs saline | lumbar nerve root compromise | 12 vs 11 | 4 w, 1 y | significant pain relief and better mobility after 4 w, at 1 y no benefit |
| Serrao et al. 1992 [105] | randomized, double blind | epidural interlaminar saline + steroid + dextrose vs saline + midazolam + dextrose | mechanical low back pain | 14 vs 14 | < 2 w, 2 m | early benefit 3 vs 10, after 2 m 5 vs 7, significantly less medication in control group |
| Carette et al. 1997 [20] | prospective randomized, double blind | lumbal translaminar | low back pain, radicular pain | 78 vs 80 | 6 w, 3 m | early benefit = better spinal mobility, less radicular pain, lower sensitivity dysfunction, at 3 m no difference |

**Table 4.** (*Cont.*)

| Author/ year | Study design | Technique | Indication | Patients | Follow-up | Outcome |
|---|---|---|---|---|---|---|
| Fukusaki et al. 1998 [43] | randomized, single blind | epidural translaminar saline vs anesthetic vs anesthetic + steroid | uni- or bilateral pseudoclaudication due to stenosis | 16 vs 18 vs 19 | 1 w, 1 m, 3 m | early benefit with anesthetic alone, steroids no effect |
| Buchner et al. 2000 [16] | prospective randomized, double blind | lumbar epidural methylprenisolone + bupivacaine vs nothing | sciatica due to LDH | 17 vs 19 | 2 w, 6 w, 6 m | after 2 w VAS, straight leg raising, functional status better in the steroid group, no difference after 6 w and 6 m |
| McGregor et al. 2001 [73] | prospective randomized | interlaminar vs caudal route | low back pain and leg pain | 19 vs 17 | 6 m | no benefit |
| Valat et al. 2003 [120] | randomized, double blind | translaminar epidural, steroid vs saline | sciatica | 42 vs 43 | 20 d, 35 d | after d 20: improvement 51 % vs 36 % (not significant), after d 35: 49 % vs 48 % success |

Note: d = day, w = week, m = months

### Lumbar Epidural Blocks

The therapeutic effect is not well based on scientific evidence

Koes et al. [59] reviewed 12 randomized clinical trials on the efficacy of **lumbar epidurally steroid injections** for low back pain and sciatica. Of the four methodologically better studies, two reported positive outcomes and two reported negative results. Overall, only six studies indicated that the epidural steroid injection was more effective than the reference treatment and six reported there was no better or worse efficacy than the reference treatment. The author concluded that the benefits of epidural steroid injections, if any, seem to be of short duration only [59]. Watts et al. [125] performed a meta-analysis of 11 placebo-controlled trials on the efficacy of epidural steroid injections in the treatment of sciatica. The methodological quality of the trials was considered generally to be good for the five studies that scored the maximum number of points. Improvement of at least 75 % or reduction in pain was considered to be a clinically useful response. Watts et al. [125] concluded that epidural steroid injections are effective in the management of patients with sciatica [125].

The controversy regarding the efficacy of **epidural steroid injections** is partly due to the methodological and technical flaws [59, 65]. According to Cluff et al. [32], there is no consensus as to the ideal method to perform epidural injection of steroids. No recommendations can be based on the literature in terms of the ideal dose and type of steroid [32].

### Cervical Epidural Blocks

The "loss of resistance" technique does not suffice for a correct needle placement

The few clinical outcome studies for cervical epidural steroid injection showed similar success rates and exhibit similar methodological flaws to the publications that focused on lumbar regions [27, 29, 40, 69, 94]. Stojanovic et al. [113] analyzed the role of fluoroscopy in cervical epidural steroid injections. In 38 epidurograms of 31 patients the loss of resistance technique was found to be false positive in 53 %. They concluded that the **loss of resistance technique** may not be an adequate method for accurate needle placement in blindly performed cervical epidural injections. Rowlingson and Kirschenbaum found that patients with cervical radiculopathy who exhibited a dermatomal pattern of sensory loss were very likely to benefit [94]. In a study of 58 patients, Cicala et al. [31] reported 41 % excellent and 21 % good results after 6 months. In the absence of controlled randomized studies on cervical epidural steroid blocks, the value of this procedure remains undetermined.

## Provocative Discography

Provocative discography distinguishes symptomatic and asymptomatic disc degeneration

In the pre-MRI era, discography provided an excellent assessment of the intradiscal structure which was not possible with any other imaging modality at that time (Fig. 3). Discography has been used as the basis of the diagnosis of discogenic pain. Today, the role of discography lies not so much in an assessment of the disc structure but rather in the possibility of **provoking pain** which can be compared to the patients' symptoms. The mechanism of pain provocation during discography is largely unknown. It is hypothesized that pathological metabolites such as neuropeptides or cytokines are expelled from the disc during discography and cause nociception at the outer annular nerve fibers that are innervated, resulting in pain [17, 127]. So far, discography remains the only method to differentiate symptomatic and asymptomatic disc degeneration.

Discography remains controversial

However, debate continues on the diagnostic value of discography because of a lack of understanding of pain pathogenesis [22–24, 78, 123].

### Indications

In our service, patients are only selected for provocative discography if they are potential candidates for surgery, i.e. the diagnostic test will influence treatment strategy. Provocative discography is indicated to differentiate symptomatic from asymptomatic disc alterations and less frequently in cases with equivocal neural compression caused by a minor disc protrusion or in the presence of annular tears (Table 5).

**Figure 3. Provocative discography**

Image showing a "normal" disc at level L4/5 (Adams I) and severe disc degeneration with contrast medium in the spinal canal of L5/S1 (Adams V).

**Table 5.** Indications for provocative discography

| |
|---|
| **Differentiation of symptomatic and asymptomatic disc alterations** |
| • Disc degeneration |
| • Annular tears (high intensity zones) |
| • Endplate changes (modic changes) |
| • Minor disc protrusions with questionable nerve root compromise |

## Technique

Inject an MRI normal disc as a negative control

Discography should be performed by a spine specialist or a dedicated radiologist with experience of the diagnostic assessment of spinal disorders. It is mandatory that the patient is awake during the procedure to allow for communication about the injection response. However, mild sedation is helpful during the procedure.

### Lumbar Discography

In lumbar discography the posterolateral approach is widely accepted as the technique of choice. A double needle technique (with a short 18-gauge external and an internal 22-gauge needle) is widely recommended [48, 116]. In patients with unilateral pain, the needle is introduced from the contralateral side to distinguish between iatrogenic and genuine pain. The needle position is verified under fluoroscopy in two planes. After accurate needle positioning, contrast medium containing an iodine concentration of 300 mg/ml is injected into each disc by using a 5-ml syringe. The amount of contrast agent injectable before leakage usually ranges from 0.8 ml to 3.0 ml before leakage [10]. Non-ionic contrast agent is injected with a 5-ml syringe until firm resistance to the injection is felt, until severe pain is provoked, or until contrast medium is seen to leak out of the disc into the spinal canal. During discography, the patient is asked to grade the pain provoked on a visual analogue scale. The type of pain should be graded according to the **Dallas Discogram Description** [97] as follows:

Pain provocation should be graded as concordant or non-concordant

- no sensation
- pressure
- dissimilar pain
- similar pain, or
- exact pain reproduction

Discogenic pain is based on the provocation of concordant pain

Pain sensation occurring during discography is defined as concordant if the patient had exact pain reproduction or felt similar pain. Accordingly, non-concordant pain is defined as pressure, dissimilar pain sensation, or no pain provocation. Evaluation of disc morphological characteristics is performed with conventional radiographs by using the classification of **Adams** et al. [1]. The classification includes five stages of disc degeneration distinguished by their morphological **appearance on discograms:**

- cotton ball (Type I)
- lobular type (Type II)
- irregular (Type III)
- fissured (Type IV)
- ruptured (Type V)

Types I and II are interpreted as non-degenerative discs and Types III–V as degenerative discs.

It has been very helpful to include an MRI normal disc as an internal control. In our practice, we only regard concordant pain predictive of discogenic pain when the injection of the control level does not provoke pain [129].

### Thoracic Discography

Thoracic discography is performed under **CT guidance** on an outpatient basis. The patient is placed in a prone position on the CT table. Following a scout film of the thoracic spine the level of interest is scanned with a section thickness of 3 mm. After choosing the target thoracic disc, the CT-table position is adjusted. The side opposite, if present, is chosen as the injection side, so as not to provoke patient pain while advancing the needle. Under CT guidance a 25-gauge needle is advanced into the target disc. After positioning of the needle in the center of the disc, contrast medium (iopamidol, 1.5 cc) is injected and a CT discogram scan performed. The patient is questioned about the pain provoked during injection as mentioned above.

Thoracic discography should only be done under CT guidance

### Cervical Discography

For this procedure, the patient lies supine with the neck in slight extension. The neck is draped in a sterile fashion. By using a 22-gauge needle, through an anteromedial approach (medial to the m. sternocleidomastoideus), the needle is advanced to the center of the disc under **biplanar fluoroscopic control**. The trachea and esophagus remain medially and the carotid artery is palpated and displaced laterally. The amount of contrast agent injected usually ranges from 0.3 ml to 1.0 ml. The pain response is assessed similarly to the lumbar procedure.

## Complications

Any needle technique carries with it the risk of infection, which appears to be most relevant in cases of cervical and lumbar discography. The reported rate for discitis after **lumbar discography** is in the order of magnitude of 0.25 % [130]. Further complications are reported such as retroperitoneal hemorrhage, allergic reaction, subarachnoidal bleeding, nerve root sheath injuries, or annular or endplate injections due to incorrect needle placement. Of 807 injected cervical discs, Grubb et al. [47] had a rate of discitis of 0.37 % corresponding to 1.7 % patients with discitis treated. In Zeidmann's [136] review of 4 400 diagnostic cervical discography cases, discitis occurred in 7 cases (0.16 %).

The rate of post-discography discitis ranges between 0.16 % and 0.37 %

## Diagnostic Efficacy

In 1948 Lindblom [50] introduced discography as a morphological test to replace or add information to myelography. Today the role of discography is related to a pain provocation test. The assessment of the **diagnostic accuracy** of provocative discography for discogenic LBP is problematic since no gold standard is available. A reasonable practical approach is to include an adjacent normal disc level as internal control [129]. Thus, a positive pain response would include an exact pain reproduction at the target level and no pain provocation or only pressure at the normal disc level. However, careful interpretation of the findings is still mandatory with reference to the clinical presentation.

Diagnostic accuracy is difficult to determine because a gold standard is lacking

### Lumbar Discography

In a prospective, controlled study, Walsh et al. [123] studied ten asymptomatic volunteers and seven symptomatic patients with low back pain by lumbar discography. In the asymptomatic individuals, the injection produced minimum pain in 5 (17 %) of the 30 discs and in 3 moderate to bad pain. The false-positive rate

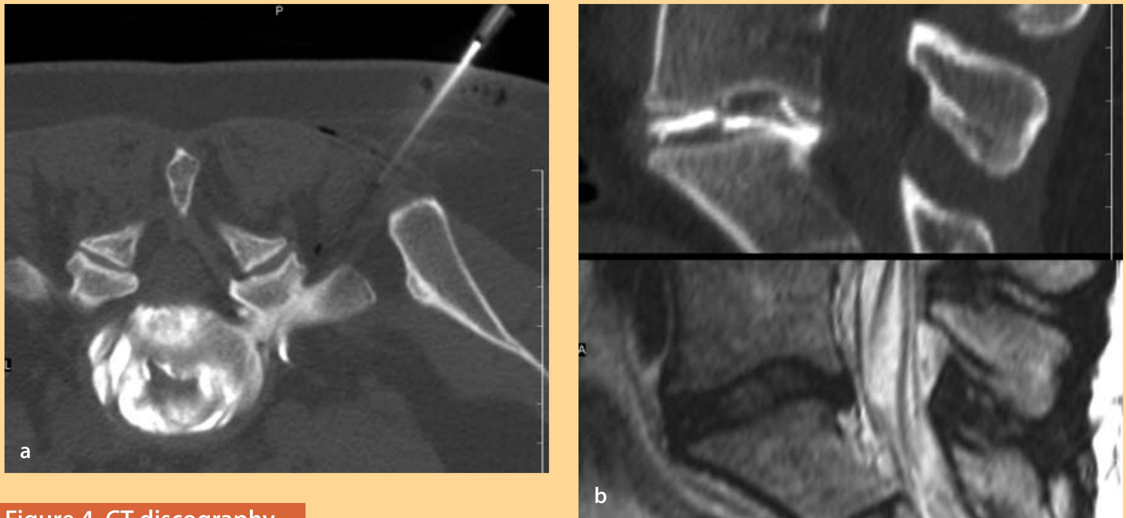


**Figure 4. CT discography**

Axial CT discogram showing contrast medium distribution within the intervertebral disc. a Sagittal view of CT/discogram showing contrast medium extension to the margin of the disc. b Corresponding MRI of the disc

of 0% and a specificity of 100% led the authors to conclude that discography is a highly reliable and specific diagnostic test for the evaluation of low back pain disorders [123]. In 1999, Caragee et al. [24] reported on patients with no history of low back pain, who underwent posterior iliac crest bone graft. These patients often experienced concordant pain on lumbar discography. However, this study can be criticized because asymptomatic patients cannot perceive concordant discogenic pain. In 2000, Carragee repeated provocative discography in 26 older subjects without history of low back pain [23]. They concluded that the rate of false-positive discography may be low in subjects with normal psychological testing and without chronic pain. Furthermore, Caragee and colleagues [23] performed provocative discography in 20 asymptomatic patients who underwent single level discectomy for sciatica. Forty percent injections were positive in discs that had previous surgery.

*The diagnostic value of discography remains a matter of debate*

Patients with low back pain who had lumbar fusion surgery based on positive discograms have been shown to have only moderate results. Complete pain relief was achieved only in a few cases. Successful clinical results ranged between 86.1% and 46%. This indicates that confounding factors other than morphological alterations may play a more important role in predicting surgical outcome (see Chapter 7).

CT discography (Fig. 4) represents a further step in the application of discography and evaluation of the structure of the disc. The debate as to whether CT/discography is superior to MRI because there is a theoretical advantage of CT/discography over MRI in demonstrating the internal architecture of the disc has not been conclusively answered. But, CT discography was found to have a higher accuracy than pain provocation and plain discography, 87% vs 64% vs 58% respectively [54, 55].

### Thoracic Discography

Thoracic discography performed by experienced radiologists with CT guidance is quite safe with a very low rate of complications. Similar to lumbar discography, it seems to be accurate in distinguishing painful symptomatic discs from asymptomatic discs. Wood et al. performed four-level thoracic discography in ten asymptomatic volunteers and compared the discograms with MRI studies. Three of the 40 discs were reported as intensely painful, all exhibiting prominent endplate infractions typical of Scheuermann's disease. Of the 40 discs studied, only 13 were judged to be normal morphologically on discography versus 20 on MRI. The remaining 27 discs were abnormal, exhibiting endplate irregularities, annular tears, and/or herniations. Wood et al. studied concomitantly thoracic discograms of ten adults with chronic thoracic pain. In this group 48 discs were analyzed, of which 24 were concordantly painful and 17 had non-concordant pain or pressure. On MRI, 21 of the 48 discs appeared normal, whereas on discography only 10 were judged as normal. The authors concluded that thoracic discography detects pathologies which may not be seen on MRI [134].

### Cervical Discography

Results of cervical discography must be interpreted carefully

Ohnmeiss et al. [82] studied 269 discs in patients with neck, shoulder and arm pain by cervical discography. Comparing the pain responses during disc injection with radiological images, they found positive pain provocation in 234 radiographically abnormal discs (77.8 %). They pointed out that it is important not just to assess pain intensity but to interpret the provoked pain in terms of its similarity to clinical symptoms. Grubb et al. [47] reviewed their 12-year experience with 807 injected cervical discs and found a 50 % concordant pain response rate. They concluded that cervical discography provokes concordant pain in multiple discs and conclusions about which disc should be treated must be drawn cautiously.

So far, provocative discography appears to be the only diagnostic test available to differentiate symptomatic and asymptomatic disc degeneration allowing for a direct relation of a radiological image to the patient's pain [49, 129].

## Facet Joint Blocks

Neck pain and low back pain may be caused by osteoarthritis of the facet joints

Since the first report by Ghormley [44], facet joints have been recognized as a predominant source of back pain. Their prevalence as a cause of low back pain has been reported to vary greatly and to range from 7.7 % to 75 % depending on the diagnostic criteria [21, 37, 53, 75–77, 99–104, 106]. Mooney and Robertson [75] demonstrated that low back pain and referred pain could be provoked by injection of hypertonic saline into the facet joints. Many authors today believe that the diagnosis of a facet joint syndrome can be based on pain relief by an intra-articular facet joint injection of an anesthetic or pain provocation by hypertonic saline injection [25, 64, 70, 76].

Today, facet joint blocks are used as a diagnostic and/or therapeutic means to eliminate pain presumably arising from the facet joints.

### Indications

Similarly to disc degeneration, a differentiation of a symptomatic and asymptomatic facet joint osteoarthritis based on imaging studies alone is not possible. Therefore, facet joint blocks alleviating the patient's symptoms presumably resulting from alteration of the facet joints are the only modality to differentiate symptomatic from asymptomatic states (**Table 6**).

**Table 6.** Indications for facet joint blocks

- differentiating symptomatic from asymptomatic facet joint alterations
- short- to medium-term relief of back pain in patients with previous positive diagnostic blocks

## Technique

### Lumbar Facet Joint Blocks

Correct needle placement should be documented by contrast agent injections

The blocks are performed under **fluoroscopic guidance** with the patient lying prone. In order to visualize the lumbar joints either the patient is rotated and supported in an oblique prone position or the X-ray beam is tilted accordingly. The angulation is usually between 30° and 40°. After disinfection the skin over the target joint is anesthetized with 2–3 ml of lidocaine. A spinal needle (22 gauge) is then inserted in a lateromedial direction (parallel to the X-ray beam) towards the joint. In obese patients, a double-needle technique is employed where a 22-gauge needle is passed through a shorter 18-gauge needle. Depending on the specific situation, either the mid point or rather the cranial or caudal part of the joint is targeted. A minimal quantity of contrast medium (<0.3 ml) is then injected under fluoroscopy to confirm the correct needle position (Fig. 5). If an intra-articular application is not possible, a periarticular injection is performed. **Needle placement** and **contrast distribution** are documented by standard radiographs. Subsequently, 1.0 ml of a mixture of local anesthetics (Carbostesin or bupivacaine and steroids, e.g. 40 mg triamcinolone) is injected. The patients are kept under surveillance for at least 15 min. All patients should be asked to assess the amount of pain prior to and 15–30 min after the injection using a visual analogue scale. Further follow-up information on the course of pain relief is helpful in interpreting the results.

### Spondylolysis Block

A special type of lumbar facet joint block is injection into the spondylolysis. This can be accomplished by injecting the facet joint located superior to the spondylolysis using the same technique as outlined above. Since the **facet capsule is often connected to the spondylolysis zone**, a filling can be observed which can extend to the inferior facet joint (Fig. 6).


**Figure 5. Lumbar facet joint infiltration**

Fluoroscopically guided lumbar facet infiltration documenting the right position of the needles with correct arthrography of the joint.

**Figure 6. Spondylolysis block**

A correct spondylosis block is performed by injecting the facet joints at the level of L4/5. Contrast medium is extending through the lysis into the facet joint L5/S1.

### Cervical Facet Joint Blocks

We prefer the posterior approach for the cervical facet joints C3/4 to C6/7. The entry point lies two segments below the target joint. The patient is positioned prone on the fluoroscopic table. A spinal needle (22 gauge) is passed through the posterior neck muscles until it strikes the back of the target joint. For safety reasons, the **CT guided fluoroscopy** can be used (Fig. 7). The accurate placement of the needle is confirmed by injection of 1 ml of contrast medium. Thereafter, the steroid and anesthetic agent can be injected. Similarly to the lumbar spine, pain relief is recorded prior to and 15–30 min after the injection using a visual analogue scale.

CT guided cervical facet blocks are relatively safe

## Complications

Although complications are possible with any invasive procedure, reports on series of thousands of facet joint injections reveal that they are relatively safe [68]. Any needle technique carries with it the risk of infection, which appears to be of little relevance in cases of cervical and lumbar facet blocks. Complications are reported such as retroperitoneal hemorrhage, allergic reaction, and nerve root sheath injuries. There were some adverse effects like headache, nausea and paresthesiae, which are transient [70]. Obviously, side effects related to the pharmacology of the anesthetic agent and corticosteroids are possible.

Complications of facet joint blocks are rare

**Figure 7. CT-guided facet block**

CT guidance for cervical facet joint blocks is preferred because of the spatial relationships to the spinal cord to avoid neurological damage. Image showing correct needle placement at the level of C5/6. Note the correct arthrography on both sides.

## Diagnostic and Therapeutic Efficacy

### Lumbar Facet Joint Blocks

Facet joint blocks tackle symptomatic facet joint osteoarthritis

Some authors suggest that a facet joint syndrome can be diagnosed based on pain relief by an intra-articular anesthetic injection or provocation of the pain by hypertonic saline injection followed by subsequent pain relief after injection of anesthetics [25, 64, 70, 76]. Jackson et al. [53] investigated clinical predictors indicative of the injection response but had to conclude that there were no clear clinical findings. Similarly, Revel et al. [89] did not find any difference in the frequency of the 90 variables examined between the responder and non-responder groups. **Uncontrolled diagnostic facet joint blocks** are reported with a false-positive rate of 38 % and a positive predictive value of 31 % [100]. It therefore is mandatory to perform repetitive infiltrations to improve the diagnostic accuracy, e.g. with two different local anesthetics as suggested by Schwarzer et al. [100]. Dreyfuss [37] has concluded that there are no convincing pathognomonic, non-invasive radiographic, historical, or physical examination findings that allow one to definitively identify lumbar facet joints as a source of low back pain and referred lower extremity pain.

Facet joints are innervated polysegmentally making interpretation of the pain response difficult

According to a randomized double blind study by Marks et al. [70], intra-articular blocks are as effective as blocks of the medial branch of the dorsal ramus. One problem of interpreting the response to a facet joint block is related to the finding that facet joints are innervated by two to three segmental posterior branches, making a diagnosis of the affected joint difficult. The evaluation of the diagnostic accuracy of joint injections to diagnose a symptomatic facet joint is difficult in the absence of a true gold standard.

Even less information is available on the therapeutic efficacy of facet joint blocks in relieving pain attributed to facet joints [21]. Carette et al. [21] selected 110 out of 190 patients who experienced pain relief of more than 50 % after an intra-articular facet joint block with 2 ml lidocaine for a double blinded randomized control trial comparing methylprednisolone versus isotonic saline injection. They showed an immediate average pain reduction in the study group of 76 % vs 79 % in the placebo group. At 6 months follow-up, however, the patients in the study group reported a significantly higher pain relief (46 % vs 15 %).

**Table 7.** Therapeutic efficacy of facet joint blocks

| Author/year | Study design | Technique | Indication | Patients | Follow-up | Outcome |
|---|---|---|---|---|---|---|
| Carette et al. 1991 [21] | randomized double-blind | intra-articular lumbar facet block saline vs steroid | low back pain | 49 vs 48 | 1, 3 and 6 m | early benefit 42% vs 33%, after 6 months 46% vs 15% |
| Marks et al. 1992 [70] | randomized, double blind | facet joint vs facet nerve | lumbar or lumbosacral pain | 42 vs 44 | 1 and 3 m | no significant difference |
| Lilius et al. 1989 and 1990 [62, 63] | randomized, not blinded | (1) intracapsular steroid + bupivacaine, (2) pericapsular steroid + bupivacaine, (3) intracapsular saline | low back pain | 28 vs 39 vs 42 | 60 min, 3 m | 64% benefit in all groups, 36% at 3 months, no significant differences between groups |
| Lynch 1986 [66] | controlled, not randomized | 2 levels intra-/extracapsular vs extracapsular | low back pain | 50 vs 15 | 6 m | positive effect in all treated patients |
| Revel et al. 1998 [88] | randomized, double blind | intra-articular lidocaine vs saline | low back pain with 7 inclusion criteria | 43 vs 37 | 30 min | significantly greater pain relief in lidocaine group, 92% of responders to facet injection had 5 out of 7 facet criteria |
| Gorbach et al. 2005 [46] | cohort, prospective | intra-articular steroid + bupivacaine or mepivacaine | low back pain | 1 level: 29<br>2 levels: 13 | 15–30 min = immediate<br>> 1 w = short term<br>> 3 m = medium term | 74% immediate pos. effect (> 50%) pain relief, 57% short term pos. effect, 33% medium term pos. effect |

Note: w = weeks, m = months

### Spondylolysis Block

There are no reports on the therapeutic value of pars infiltration. But, clinicians who use pars infiltration preoperatively for patient selection have described that patients with pain relief are more likely to be pain free after lumbar fusion. Patients without pain relief after pars infiltration could have other sources of pain. Suh et al. reported that patients selected with positive pars infiltration were more likely to have pain relief, to be functional, and to return to work [115].

### Cervical Facet Joint Block

The result of facet joint blocks is difficult to predict

So far, the accuracy and reliability of cervical facet blocks has not been demonstrated.

Few data also exist about the therapeutic efficacy of therapeutic cervical facet joint injections. One observational study found no benefit of cervical intracapsular steroid injections in patients with chronic pain after whiplash injury [2].

## Sacroiliac Joint Blocks

The sacroiliac joints are helpful in the diagnosis of a symptomatic sacroiliac joint

Alterations of the sacroiliac (SI) joints remain a **diagnostic and therapeutic obstacle.** Every joint can cause pain; therefore it is highly likely that pain can also result from the SI joint [98]. Pain from the SI joint has been referred to the region medial to the posterior superior iliac spine called the sacral sulcus. The pain can also radiate into the groin, abdomen and thigh, which makes it difficult to distinguish SI joint pain from disc disease or facet arthropathy [41, 42]. The clinical diagnosis is difficult to make since none of the clinical signs and tests has proven to be predictive. Imaging is not very helpful in diagnosing painful SI joint arthropathy in patients without inflammatory sacroiliitis [118]. A diagnostic anesthetic block of the sacroiliac joint is a possibility for identifying this structure as a relevant source of pain [96]. Slipman et al. [109] suggested that the painful sacroiliac joint is caused by a mild synovial irritation, which is not detectable on imaging. Other researchers assume that there is a chemical irritation of the nerves innervating the joint by mediators from the joint fluid [41].

Therefore, the rationale for SI joint blocks is to support the clinical diagnosis of an SI joint pathology.

### Indications

Indications for sacroiliac joint blocks include the **diagnostic work-up** for patients with low back and buttock pain radiating into the posterior thigh. **Therapeutic infiltrations** have not been reported to be of long-lasting success and are therefore not very helpful.

### Technique

This joint is for most of its extent inaccessible to needles due to the rough corrugated interosseous surfaces of the sacrum and the ileum. However, Bogduk et al. [7] have described puncturing the joint from its inferior end where the joint appears below the interosseous ligament and reaches the dorsal surface of the sacrum deep to the gluteus muscles. The accurate method of sacroiliac joint injection usually requires fluoroscopy or computed tomographic control [38, 39, 50, 108].

CT fluoroscopy facilitates correct needle placement

We describe here the technique which has been helpful in our service. With the patient lying prone the entry point of the joint lies at the lower end of the joint and is identified with fluoroscopic aid. **CT guidance** is necessary in patients with a complex orientation of the sacroiliac joint (Fig. 8). In some patients even the intra-articular access can be impossible, also due to fusion of the joint. After sterile skin preparation and draping, a 25-gauge needle (22 gauge) is introduced through the skin directed to the posterolateral aspect of the sacrum and then readjusted to enter the slit of the joint above the inferior edge. Once the needle is in position, contrast medium is injected to confirm the correct position. Subsequently steroids and anesthetic agents can be injected for diagnostic and therapeutic purposes.

### Complications

Complications due to **sacroiliac joint injections** are rare. Extravasation of anesthetic agent around the sciatic nerve can cause temporary numbness in up to 5 % of patients. If the needle is advanced too inferiorly, contact with the sciatic nerve is possible [118].

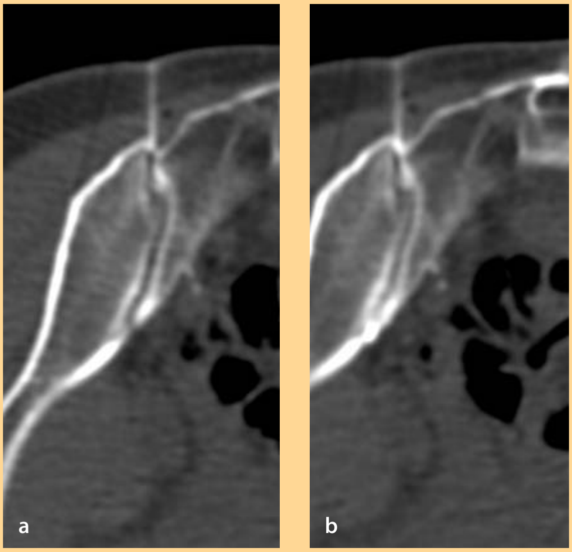


**Figure 8. Sacroiliac joint block**

Images showing correct needle placement (a) and arthrography of the sacroiliac joint (b).

## Diagnostic Efficacy

Sacroiliac joint infiltration allows for the diagnosis of a painful joint

Literature on sacroiliac joint injections and their impact on diagnosis and impact is sparse [98]. No prospective or controlled evaluation of the technique has been published. A few retrospective studies exist on the efficacy of sacroiliac joint injections.

In the report by Maugurs et al. [72], 86 % of patients had good pain relief after sacroiliac joint injection after 1 month, which decreased to 58 % after 6 months. In the study by Bollow et al. [8], 92 % of the 66 investigated patients had pain relief. In Fortin's study, 88 % of 16 patients with non-inflammatory sacroiliac joint syndrome had a decrease in pain after injection of anesthetic agent [41]. Slipman et al. [108] selected 31 patients with pain in the sacral sulcus, positive stress test and relief of pain after a first sacroiliac injection with anesthetic agent. After a second injection with an additional steroid mixture the patients had a significant decrease in pain scores and improved functional status after a follow-up of 94 weeks.

Today low back pain from the sacroiliac joint is best diagnosed when there is relief of pain after injection of anesthetic agent. There is no gold standard for verifying the presence of sacroiliac joint pain to which the results of sacroiliac diagnostic block can be compared. Thus, there are no reliable data on the sensitivity and specificity of this test [96].

## Contraindications for Spinal Injections

There are few contraindications for spinal injections, which must be considered before performing an infiltration. Alteration of the normal anatomy, e.g. pronounced degenerative abnormalities, or after major surgery to the spinal canal, where the positioning of the needle could be technically impossible, is per se not a contraindication.

However, it is apparent that such injections can only be performed in patients with normal hemostasis and without known allergic reactions. History taking on potential allergic reactions is mandatory and laboratory screening strongly recommended prior to the injections. Injections should not be performed in patients with:

- bleeding diathesis
- full anticoagulation, whereas medication with acetylsalicylic acid does not represent a contraindication
- infections or immunodeficiency syndromes
- allergic reaction to anesthetic agents or steroids

## Algorithm for Spinal Injections

The evidence for the diagnostic value of injection studies remains controversial

The clinical investigation and patient history is of the utmost importance and should allow the clinician to differentiate between a local pain syndrome (neck pain, lumbar pain, dorsal pain, sacroiliac syndrome) and radicular pain, neurogenic claudication, segmental instability and discogenic pain. Despite the dilemma of unproven diagnostic and therapeutic efficacy of spinal injections [61], a practical approach appears to be justifiable until more conclusive data is provided in the literature. We therefore want to summarize an evidence-enhanced approach as currently used in our center. However, we want to stress that this approach is subjective and predominately anecdotal but appears to work in our hands (Fig. 9).

Persistence (for more than 3 months) of non-radicular local pain which is not alleviated by conservative therapy should be investigated with radiographs and MRI. For radicular pain without or with minor neurological deficit these tests should be done after 3 weeks. Every pain syndrome with major neurological deficit and in cases which are suspicious for tumor or infection of the spine requires

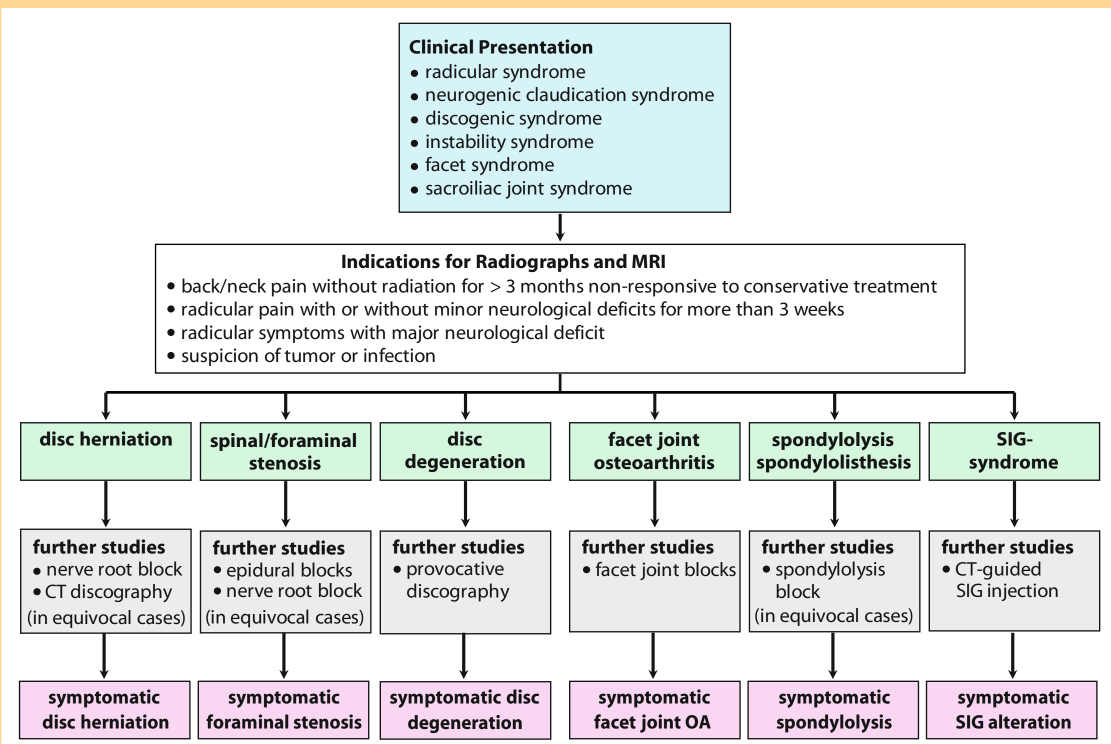


Figure 9. Algorithm for diagnostic spinal injection studies

immediate MRI investigation. If no clear correlation between clinical examination and radiological findings can be established, spinal injections are recommended.

In patients with disc herniation and unequivocal root compression, **selective nerve root block**s may support conservative treatment [86, 114]. In selected cases, nerve root blocks can substantially reduce the proportion of patients requiring a surgical intervention for the treatment of a radiculopathy often allowing for immediate pain relief [79, 91]. **Selective nerve root blocks** are helpful in cases with equivocal morphological findings to confirm the diagnosis. If the patient's pain is alleviated for the duration of the anesthetic effect, involvement of the target nerve root in the pain pathogenesis is very likely. Similarly, nerve root compression due to foraminal stenosis is an indication for nerve root block. Patients with spinal stenosis who are not candidates for surgery and have multisegmental alterations may benefit from **epidural blocks**. However, our anecdotal experience indicates that these injections are less effective than nerve root blocks.

We regard **discography** as the only means to differentiate symptomatic from asymptomatic disc degeneration since the morphological appearance can be identical [9, 12]. Our interpretation for a symptomatic disc degeneration is based on an exact pain provocation in the absence of pain provocation in an adjacent MR normal disc [129]. However, we only perform discography in patients who we would select for surgery in case of an exact pain provocation. In our center, we do not use discography for a pure diagnostic work-up.

Debate continues on the clinical significance of facet joint osteoarthritis as a source of back pain. So far, a definition of a facet syndrome has widely failed. Nevertheless, one-third of patients presenting with symptoms suggestive of a symptomatic facet joint arthropathy can benefit from a **facet joint block** for a short period of time (3–6 months) [46]. We recommend facet joint blocks in elderly patients who prefer non-surgical treatment as an adjunct therapy in the presence of moderate to severe facet joint osteoarthritis. However, we are ambivalent about the diagnostic accuracy of **facet joint and spondylolysis blocks** to support the indication for surgery or selection of fusion levels.

The diagnosis of SI joint alterations as a source of back pain remains unsatisfactory. We regard **SI joint blocks** as the only means to diagnose the involvement of the target joint. However, these injections are not very helpful in alleviating the patient's pain on a medium to long term.

## Recapitulation

**Rationale.** Although injection studies aim to **provoke or eliminate pain** and therefore focus on the source of the problem, there is as yet insufficient evidence to prove clinical efficacy as a diagnostic tool.

**Selective nerve root.** Selective nerve root blocks are used in cases with **equivocal radicular pain** and morphological findings to confirm the diagnosis. If the patient's pain is elevated for the duration of the anesthetic effect, involvement of the target nerve root in the pain pathogenesis is very likely. Selective nerve root blocks are also very helpful in supporting non-operative care in patients presenting with cervical and lumbar radiculopathy. In selected cases, nerve root blocks can substantially reduce the proportion of patients requiring a surgical intervention for the treatment of a radiculopathy often allowing for immediate pain relief.

**Epidural and caudal blocks.** Epidural and caudal application of steroids is used to treat **inflammation** due to compression of one or multiple nerve roots. Whereas low back pain, e.g. discogenic pain, seems not to be a good indication for epidural or caudal blocks, patients with neurogenic claudication may benefit from this injection. However, it seems that epidural blocks are **less effective than nerve root blocks**.

**Provocative discography.** Discography is the **only means** to differentiate symptomatic from asymptomatic disc degeneration since the morphological appearance can be identical. Interpretation for symptomatic disc degeneration is based on an exact pain provocation in the absence of pain provocation in an adjacent MR normal disc. However, discography should be performed in patients who we would **select for surgery** in the case of an exact pain provocation.

**Facet joint blocks.** Debate continues on the clinical significance of facet joint osteoarthritis as a source of back pain. While it would be unreasonable to assume that **facet joint osteoarthritis** is painless, the clinical presentation of facet joint alterations is variable. So far, a definition of facet syndrome has widely failed. However, the diagnostic accuracy of facet joint blocks to support the indication for surgery or selection of fusion levels should be interpreted with caution.

**Sacroiliac joint blocks.** The diagnosis of SI joint alterations as a source of back pain remains unsatisfactory. SI joint blocks are the only means to diagnose the affection of the target joint. However, these injections are not very helpful in alleviating the patient's pain on a medium to long term.

## Key Articles

**Revel M, Poiraudeau S, Auleley GR et al. (1998) Capacity of the clinical picture to characterize low back pain relieved by facet joint anesthesia: proposed criteria to identify patients with painful facet joints. Spine 23:1972–1976**
In this article patients with low back pain were prospectively randomized into two groups with and without clinical criteria predictive of facet joint osteoarthrosis. After facet joint blocks, greater pain relief was observed in the back pain group. The presence of age greater than 65 years and pain that was not exacerbated by coughing, not worsened by hyperextension, not worsened by forward flexion, not worsened when rising from flexion, not worsened by extension-rotation, and well relieved by recumbency distinguished 92 % of patients responding to lidocaine injection and 80 % of those not responding in the lidocaine group. The authors conclude that five clinical characteristics can be used to select lower back pain that will be well relieved by facet joint anesthesia.

**Carragee EJ, Alamin TF (2001) Discography: a review. The Spine Journal 1:364–372**
This paper describes the indication and technique of discography. Further, articles that are relevant to discography are systematically reviewed. Especially the interpretation of the results and conclusion are discussed. The authors state that the specificity of discography is dramatically affected by psychosocial characteristics of the patient. The ability of a patient to determine reliably the concordancy of pain provoked by discography is poor. The authors concluded that clinicians who use discography need to critically examine the validity of the test.

**Karppinen J, Malmivaara A, Kurunlahti M et al. (2001) Periradicular infiltration for sciatica: a randomized controlled trial. Spine 26:1059–1067**
In this randomized, double blind trial the efficacy of periradicular corticosteroid injection for sciatica was tested. One-hundred and sixty patients were randomized for double blind injection with methylprednisolone/bupivacaine combination or saline. Recovery rate was better in the steroid group at 2 weeks for leg pain, straight leg raising, lumbar flexion, and patient satisfaction. Back pain and leg pain were significantly lower in the saline group at 6 months. By 1 year, 18 patients in the steroid group and 15 in the saline group underwent surgery. The authors concluded that improvement was found in both groups and the combination of methylprednisolone and bupivacaine seems to have a short-term effect, but at 3 and 6 months the steroid group seems to experience a rebound phenomenon.

**Vad V, Bhat A, Lutz G, Cammisa F (2002) Transforaminal epidural steroid injections in lumbosacral radiculopathy: a prospective randomized study. Spine 27:11–15**
In this randomized study of 48 patients with radiculopathy secondary to a herniated nucleus pulposus, one group received a transforaminal steroid injection and the other saline trigger-point injection. After an average follow-up period of 1.4 years, the group

receiving transforaminal steroid injections had a success rate of 84 %, as compared with 48 % for the group receiving trigger-point injections.

**Slipman CW, Bhat AL, Gilchrist RV, et al. (2003) A critical review of the evidence for the use of zygapophysial injections and radiofrequency denervation in the treatment of low back pain. Spine J 3:310 – 316**
A database search of Medline, Embase and the Cochrane database was conducted to perform a critical review of studies that analyze the treatment of lumbar facet joints with intra-articular injections and radiofrequency denervation. The authors concluded that current studies give sparse evidence to support the use of interventional techniques in the treatment of lumbar zygapophyseal joint-mediated low back pain.

**Koes BW, Scholten RJPM, Mens JMA, Bouter LM (1995) Efficacy of epidural steroid injections for low-back pain and sciatica: a systematic review of randomized clinical trials. Pain 63:279 – 288**
Twelve randomized clinical trials evaluating epidural steroid injections were analyzed. In this analysis six studies indicated that the epidural steroid injection was more effective than the reference treatment and six reported it to be no better or worse than the reference treatment. The authors concluded that the efficacy of epidural steroid injections has not yet been established and the benefits of epidural steroid injections, if any, seem to be of short duration only.

**Bollow M, Braun J, Taupitz M, et al. (1996) CT-guided intraarticular corticosteroid injection into the sacroiliac joints in patients with spondyloarthropathy: indication and follow-up with contrast-enhanced MRI. J Comput Assist Tomograph 20:512 – 521**
This article prospectively analyzes the therapeutic efficacy of CT-guided intra-articular corticosteroid instillation of inflamed sacroiliac joints in patients with spondyloarthropathies. The role of MRI as a test for indication and follow-up was evaluated. Sixty-one of 66 patients who underwent instillation of corticosteroid showed a statistically significant reduction of subjective complaints. Also the percentage of contrast enhancement on dynamic MRI showed a significant reduction.

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