Skeletal Radiol (2010) 39:5–9
DOI 10.1007/s00256-009-0783-x

REVIEW ARTICLE

Evidence-based radiology (part 1): Is there sufficient research to support the use of therapeutic injections for the spine and sacroiliac joints?

Cynthia Peterson · Juerg Hodler

Received: 1 July 2009 / Revised: 14 August 2009 / Accepted: 17 August 2009 / Published online: 3 September 2009

Abstract
Introduction This review article addresses the best evidence currently available for therapeutic injection therapy for conditions targeting the spine and sacroiliac joints. The article is presented by spinal region. Controversies and areas of interest for further studies are identified.
Discussion There is conclusive evidence supporting the effectiveness of the caudal approach for the administration of epidural steroid injections for patients with low back pain from a variety of causes. In general, there is moderate-to-strong evidence supporting the use of transforaminal therapeutic epidural injections for lumbar nerve-root compression and facet injections for joint pain arising from these joints in the cervical, thoracic and lumbar spine, but further subgroup analysis is needed to help predict which specific patients may receive the most benefit from these procedures.
Conclusion No randomized controlled trials, meta-analyses or systematic reviews addressing the effectiveness of therapeutic sacroiliac joint injections have been found. For some injections, corticosteroids may not provide better outcomes compared to local anesthetic injections alone.

Keywords Therapeutic injections · Joint injections · Corticosteroid injections · Epidural injections · Therapeutic joint injections

C. Peterson (✉) · J. Hodler
Radiology, Orthopaedic University Hospital of Balgrist,
Forchstrasse 340,
8008 Zürich, Switzerland
e-mail: cynthia.peterson@balgrist.ch

J. Hodler
e-mail: juerg.hodler@balgrist.ch

Introduction

Back and neck pain are amongst the most common conditions presenting to physicians. Treatment may be expensive and some therapies have not been proven to be effective based on the principles of evidence-based medicine. Most patients with non-surgical conditions or those who are not good surgical candidates, are provided with conservative care such as exercise therapy, educational interventions, manipulation or mobilization, various physical therapy treatments, or pharmacological interventions [1]. When these treatments do not alleviate their symptoms, many are then referred for imaging guided diagnostic and/or therapeutic joint or nerve-root injections. *Diagnostic* injections are employed to determine whether or not a particular anatomical structure or structures is the cause of the patient's symptoms. This may involve two separate injections into the specific joint or surrounding the nerve root of interest, each injection consisting of a local anesthetic with a particular length of action. The patient's response to these anesthetics is measured and compared with the expected duration of action of each drug [2–6]. *Therapeutic* injections are similar in procedure, but usually contain a corticosteroid in addition to a local anesthetic, assuming that the steroid targets any inflammation occurring in or around the structure and therefore prolongs the therapeutic effect.

A search of the existing literature was performed according to the principles of evidence-based medicine. The effectiveness of therapeutic injections was assessed for each spinal region. Best practice is described. Areas are identified where further research is desirable. Cervical nerve-root injections are not included in this review as there are doubts regarding their safety after severe ischemic abnormalities of either the brain or the spinal cord have

been reported [7] and these injections should not be promoted in the authors' opinion. This paper is primarily based on systematic reviews and meta-analyses when available. Randomized clinical trials (RCTs) are included when systematic reviews or meta-analyses are not available. The search strategy focused primarily on PubMed. The 'links' and 'limits' functions were used to specifically find reviews, meta-analyses, randomized controlled trials (RCTs), and clinical trials. The Cochrane database, Google scholar and references for articles retrieved were also included in our search.

Based on this methodology, which in evidence-based medicine is traditionally considered the 'best evidence', practical experience, expert opinion, cohort studies and guidelines are not widely represented. Therefore, the conclusions of this review paper may not reflect positively on some of the commonly performed therapeutic injections, probably indicating a need for additional and more stringent research, but also a reconsideration as to what constitutes 'best evidence' for the procedures discussed below.

Lumbar spine nerve-root blocks

The level of evidence for the effectiveness of therapeutic nerve-root blocks in the lumbar spine is strong for short term and moderate for long-term relief according to a recent systematic review [8]. Several of the studies included in this systematic review reported significant long term (up to 5 years) improvement in pain, walking tolerance and standing in approximately 50–75% of patients. Significant improvement was usually defined as >50% reduction in pain scores using numerical pain rating scales, with up to 50% of the patients treated avoiding surgery in one study (Table 1). However, there still remains some controversy concerning the effectiveness of these treatments due to the relative lack of randomized clinical trials using placebo controls as well as variability in the drugs used and outcome measures applied [9, 10]. Many studies are retrospective or are prospective on small populations [4, 11, 12]. Furthermore, a recent review noted that selective nerve-root injections of corticosteroids had no therapeutic effect on the long-term natural history of radiculopathy in the lumbar spine [13]. Interestingly, there also appears to be a difference in treatment outcomes between those lumbar nerve-root patients whose compression is due to a disc herniation as compared to those whose compression is from degenerative stenosis [14, 15]. Patients whose radiculopathy is due to degenerative stenosis often report worse outcomes [15], but one study found that 75% of the 34 degenerative stenosis patients enrolled had >50% pain reduction after the injection [15]. Most research studies do not analyze these subgroups separately [8–10, 12, 14, 16, 17] and this issue is further complicated by research suggesting that the location of the disc herniation within the spinal canal influences the response to nerve-root injection therapy [18, 19]. Patients whose herniations are more laterally located in or near the foramina appear to respond significantly better to these injections [18, 19]. This call for specific subgroup comparisons in treatment responses seems to be a common theme amongst researchers, particularly those doing systematic reviews, as well as clinicians [9, 10, 16, 20, 21] and would provide valuable information to patients and clinicians deciding on appropriate therapeutic options.

Lumbar epidural injections

In addition to nerve-root blocks (transforaminal injections), epidural steroid injections can also be given by either an inter-laminar or caudal approach [8, 22–24]. A systematic review of the literature published in 2007 evaluated the evidence for these three different approaches to treating patients with lumbar radiculopathy or post-lumbar laminectomy syndrome [8]. Both nerve-root blocks and epidural injections via the caudal approach demonstrated strong evidence for short-term pain relief and moderate evidence for long-term pain relief, evaluated at 6-month follow-up in some of the studies, whereas with the inter-laminar epidural approach, the evidence was strong for short-term relief but limited for long-term pain relief. A more recent systematic

Table 1 Summary of studies included in systematic review of transforaminal lumbar epidural steroid injections in chronic pain patients [6]

Study type	Study number	Total patients	Outcome measure used	Conclusions
Blinded RCTs	5	>289	Pain scales + numerous other functional measures (questionnaires and examination)	4 studies = positive short and long-term relief. 1 study = negative short and long-term relief (43 pts)
Non-blinded RCTs	1	60	Pain scale only	Negative short and long-term relief
Prospective evaluations	5	525	Pain scales and numerous other functional measures (questionnaires and examination)	4 studies = positive short and long-term relief. 1 study = positive short term, negative long-term relief

review [24] looking specifically at the transforaminal epidural approach, reported the same results; strong for short-term pain relief and moderate for long-term pain relief.

The inter-laminar epidural approach was further evaluated in a 2009 systematic review. This paper pointed out that all research studies up to 2008 used a blinded injection approach rather than an imaging guided approach and thus the results do not represent current interventional pain management practice [22]. Using the blinded injection approach, the level of evidence supporting inter-laminar epidural steroid injections specifically for patients with disc herniation or radiculitis was moderate for short-term pain relief but indeterminate for long-term relief. Studies evaluating the effectiveness of imaging guided inter-laminar injections of steroids are needed in order to make accurate comparisons with the transforaminal and caudal injection methods.

The evidence supporting the superiority of the caudal approach for epidural steroid injections is reported in a 2009 systematic review [23]. At this point in time, there is conclusive evidence (level I; Table 2) that this approach is effective for short (≤6 months) and long-term (>6 months) pain relief in patients with lumbar disc herniation and/or radiculitis, as well as for patients with discogenic pain without herniation or nerve-root compression. Effectiveness was usually determined to be at least 50% reduction in pain. Thus the current level of evidence for epidural injections of corticosteroids into the lumbar spinal region indicates that the caudal approach is best, followed by the transforaminal (nerve-root block) approach. The inter-laminar injection method currently has the lowest level of evidence supporting its effectiveness, but the reported studies do not include an imaging guided approach, as is recommended in interventional pain management guidelines [22].

Lumbar spine facet joint blocks

Lumbar spine facet joint injections are a therapeutic option when symptoms are shown to arise from these joints [21]. A recently published systematic review, including two studies with a total of 161 patients, concluded that there is moderate evidence that lumbar facet joint injections are effective in providing short and long-term pain relief even at 3 and 6 months post injection [4]. In one of the two studies evaluated, 42% of the patients reported marked or very marked improvement. A more recent systematic review in 2009 [25], along with the Cochrane review of injection therapy for subacute and chronic low-back pain patients in 2008 [10] stated that there is no strong evidence for or against the use of any type of injection therapy for these individuals. The controversy over this issue continues with a more recent randomized, double-blind controlled trial with 1-year follow-up [26] which found significant improvement in pain levels and functional status in patients receiving lumbar facet joint injections, but it made no difference whether or not that injection included a steroid preparation in addition to the local anesthetic. Although no placebo control group was used, 82–93% of the patients in both the local anesthetic group and the corticosteroid plus local anesthetic group reported significant pain relief of ≥50%.

As with therapeutic injections for patients suffering from lumbar radiculopathy, subgroup analysis in lumbar facet joint injection patients, looking at pain, disability and overall satisfaction outcomes, is also important. Wasan et al. [20] demonstrated that low back pain patients who rated ‘high’ on measurements of psychopathology as a co-morbid factor, not only had worse outcomes from their facet joint injections compared to patients with ‘low’ levels of psychopathology, their pain was actually rated as increased after the procedure.

Table 2 Categories of levels of evidence [2, 6]

Level of evidence	Conclusion	Criteria
Level I	Conclusive	Evidence from meta-analysis of RCTs. Systematic review of Level I RCTs. One high-quality RCT
Level II (also called II-1 by USPSTF)[a]	Strong	Evidence from at least 1 well conducted RCT; or evidence from multiple, properly designed studies of smaller size; or multiple low quality trials
Level III (also called II-2 by USPSTF)	Moderate	Evidence from well-designed pseudo RCTs; or evidence from comparative studies (cohort, case-controlled, or interrupted time series with a control group)
Level IV (also called II-3 by USPSTF)	Limited	Evidence from case series (no historical controls). Evidence from well-designed, non-experimental studies from >1 center or research group, or conflicting evidence with inconsistent findings in multiple trials
Level V (also called III by USPSTF)	Indeterminate	Opinions of respected authorities, based on clinical evidence, descriptive studies, case reports, reports from expert committees

[a] US Preventive Services Task Force

Sacroiliac joint blocks

Two recent systematic reviews [2, 27] and one prospective case series study [28] have assessed sacroiliac joint blocks. There is moderate evidence supporting diagnostic sacroiliac joint injections, but based on the criteria of evidence-based medicine, the effect of therapeutic SI joint injections is not sufficiently proven, due to missing controlled diagnostic blocks to first establish that pain is arising from the sacroiliac joints and lack of at least a 6-month follow-up period [2].

Liliang et al. [28] addressed this in a prospective case series study involving 39 patients. They only included patients who had positive responses to two or more diagnostic sacroiliac joint blocks and followed the patients for at least 26 weeks. A positive outcome was defined as at least 50% pain reduction on the visual analogue scale (VAS) and therapeutic effect lasting longer than 6 weeks. Of the 39 patients included in the study, 26 (66.7%) reported greater than 50% pain reduction for more than 6 weeks, with the mean duration of pain reduction being 36.8±9.9 weeks after the second sacroiliac joint block. Patients with lumbar or lumbosacral fusion had a poorer response to the sacroiliac joint blocks compared to patients without fusion (42% compared to 78%).

Borowsky and Fagen [29] found that a combined intra-articular and peri-articular injection around the sacroiliac joint had significantly better outcomes (defined as ≥50% pain reduction on a visual analogue scale) compared to the intra-articular injection alone. Only 12.5% of patients receiving the intra-articular injection reported a positive response at 3 months post injection, compared to 31.25% of patients receiving the combined injection method. Virtually all other studies on the sacroiliac joint only investigated intra-articular injections.

Thoracic spine facet blocks

Little has been published regarding this region of the spine. Three studies were included in a systematic review of the literature [6]. They provided strong evidence for both the diagnostic as well as the therapeutic use of facet joint blocks in the thoracic spine. However, the fact that all studies evaluated came from the same medical center, makes further research from other sites important.

Cervical spine facet joint blocks

Cervical facet joints have been shown to be the source of pain in 36–67% of chronic neck pain sufferers, using imaging guided diagnostic facet joint blocks [3, 5]. A recent systematic review of the literature [3] concludes that the evidence for the diagnosis of cervical facet joint pain is *level I or II-1*, whereas the level of evidence for *therapeutic* blocks is *level II-1* (Table 2). However, little has been published, particularly for *therapeutic* injections. A double-blind RCT with 1-year follow-up that was included in the systematic review, found that cervical facet joint blocks for pain relief (therapeutic blocks) provide effective treatment [30]. This study used several outcome measures including the NDI (neck disability index), opioid intake, and work status as well as strictly following the recommended protocol of first diagnosing facet joint pain using comparative, controlled diagnostic blocks. Significant pain relief was defined as ≥50%. More than 80% of their patients had this level of relief at 12 months. The average number of treatments with injections during the 1-year period was 3.5. No difference in outcomes between those who were treated with steroids compared to those treated with anesthetic (bupivacaine) alone was found. A similar study involving the lumbar facet joints, by many of these same authors, obtained the same results, finding no benefit for the addition of a steroid preparation.

Critical discussion of methods of evidence-based medicine

RCTs may not be the only method for evaluating interventional pain medicine techniques [31]. Large, well-designed observational studies tend to demonstrate less variability and heterogeneity of the population, making the evaluation of sub-groups more feasible [32]. Therefore, although this paper's focus is a best-evidence review, it could be argued that RCTs, systematic reviews and meta-analyses, while traditionally considered the best evidence, may not actually be the best evidence to support the use of therapeutic injections and certainly these papers are not the only evidence that should be used to evaluate these procedures. Additionally, statistical analyses in future studies should focus on the use of confidence intervals (CI), reporting risk ratios and especially reporting the proportion of patients who significantly improve as well as the 'numbers needed to treat' rather than relying only on *p* values [33, 34]. This may provide more clinically meaningful information that can be easily interpreted by clinicians and thus incorporated into their decision-making regarding therapeutic interventions.

Conclusions

There is conclusive evidence supporting the effectiveness of the caudal approach for the administration of epidural steroid injections for patients with discogenic low back pain

as well as for patients with disc herniations with and without radiculopathy. There is moderate to strong evidence supporting the use of therapeutic transforaminal injections for lumbar nerve-root compression and injections into the facet joints, but further subgroup analysis is needed to help predict which specific patients may receive the most benefit from these procedures. Whether or not corticosteroids provide better outcomes compared to local anesthetic injections alone requires additional studies.

References

1. Airaksinen O, Brox JI, Cedraschi C, et al. European guidelines for the management of chronic nonspecific low back pain, chapter 4. Eur Spine J. 2006;15(suppl 20):S192–300.
2. Rupert MP, Lee M, Manchikanti L, Datta S, Cohen SP. Evaluation of sacroiliac joint interventions: a systematic appraisal of the literature. Pain Physician. 2009;12:399–418.
3. Falco FJE, Erhart S, Wargo BW, Bryce DA, Atluri S, Datta S, et al. Systematic review of diagnostic utility and therapeutic effectiveness of cervical facet joint interventions. Pain Physician. 2009;12:323–44.
4. Boswell MV, Colson JD, Sehgal N, Dunbar EE, Epter R. A systematic review of therapeutic facet joint interventions in chronic spinal pain. Pain Physician. 2007;10:229–53.
5. Sehgal N, Dunbar EE, Shah RV, Colson J. Systematic review of diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: an update. Pain Physician. 2007;10:213–28.
6. Atluri S, Datta S, Falco FJE, Lee M. Systematic review of diagnostic utility and therapeutic effectiveness of thoracic facet joint interventions. Pain Physician. 2008;11:611–29.
7. Scanlon GC, Moeller-Bertram R, Romanowsky SM, Wallace MS. Cervical transforaminal epidural steroid injections. More dangerous than we think? Spine. 2007;32:1249–56.
8. Abdi S, Datta S, Trescot AM, Schultz DM, Adlaka R, Atluri SL, et al. Epidural steroids in the management of chronic spinal pain: a systematic review. Pain Physician. 2007;10:185–212.
9. Datta S, Everett CR, Trescot AM, Schultz DM, Adlaka R, Abdi SA, et al. An updated systematic review of the diagnostic utility of selective nerve root blocks. Pain Physician. 2007;10:113–28.
10. Staal JB, de Bie R, de Vet HCW, Hildebrandt J, Nelemans P. Injection therapy for subacute and chronic low back pain. Cochrane Database of Systematic Reviews 2008, Issue 3, Art. No.: CD001824. CD001824.pub3. doi:10.1002/14651858
11. Kalichman L, Li L, Kim DH, Guermazi A, Berkin V, O'Donnell CJ, et al. Facet joint osteoarthritis and low back pain in the community-based population. Spine. 2008;33:2560–5.
12. Riew KD, Yin Y, Gilula L, Bridwell KH, Lenke LF, Lauryssen C, et al. The effect of nerve-root injections on the need for operative treatment of lumbar radicular pain: a prospective, randomized, controlled, double-blind study. J Bone Joint Surg Am. 2000;82-A:1589–93.
13. Karnezis IA. Minimally invasive therapeutic interventional procedures in the spine: an evidence-based review. Surg Technol Int. 2008;17:259–68.
14. Boswell MV, Trescot AM, Datta S, Schultz DM, Hansen HC, Abdi S, et al. Interventional techniques: evidence-based practice guidelines in the management of chronic spinal pain. Pain Physician. 2007;10:7–111.
15. Botwin KP, Gruber RD, Bouchlas CG, Torres-Ramos FM, Saneli JT, Freeman ED, et al. Fluoroscopically guided lumbar transforaminal epidural steroid injections in degenerative lumbar stenosis: an outcome study. Am J Phys Med Rehabil. 2002;81:898–905.
16. DePalma MJ, Bhargava A, Slipman CW. A critical appraisal of the evidence for selective nerve root injection in the treatment of lumbosacral radiculopathy. Arch Phys Med Rehabil. 2005;86:1477–83.
17. Ng L, Chaudhary N, Sell P. The efficacy of corticosteroids in periradicular infiltration for chronic radicular pain: a randomized, double-blind, controlled trial. Spine. 2005;30:857–62.
18. Choi SJ, Song JS, Kim C, Shin MJ, Ryu DS, Ahn JH, et al. The use of magnetic resonance imaging to predict the clinical outcome of non-surgical treatment for lumbar intervertebral disc herniation. Korean J Radiol. 2007;8:156–63.
19. Strobel K, Pfirrmann CWA, Schmid M, Hodler J, Boos N, Zanetti M. Cervical nerve root blocks: indications and role of MR imaging. Radiology. 2004;233:87–92.
20. Wasan AD, Jamison RN, Pham L, Tipirneni N, Nedeljkovic SS, Katz J. Psychopathology predicts the outcome of medial branch blocks with corticosteroid for chronic axial low back or cervical pain: a prospective cohort study. BMC Musculoskelet Disord. 2009;10:22.
21. Henschke N, Maher CG, Refshauge KM, Das A, McAuley JH. Low back pain research priorities: a survey of primary care practitioners. BMC Fam Pract. 2007;8:40.
22. Parr AT, Diwan S, Abdi S. Lumbar interlaminar epidural injections in managing chronic low back and lower extremity pain: a systematic review. Pain Physician. 2009;12:163–188.
23. Conn A, Buenaventura RM, Datta S, Abdi S, Diwan S. Systematic review of caudal epidural injections in the management of chronic low back pain. Pain Physician. 2009;12:109–35.
24. Buenaventura RM, Datta S, Abdi S, Smith HS. Systematic review of therapeutic lumbar transforaminal epidural steroid injections. Pain Physician. 2009;12:233–51.
25. Chou R, Atlas SJ, Stanos SP, Rosenquist RW. Nonsurgical interventional therapies for low back pain: a review of the evidence for an American pain society clinical practice guideline. Spine. 2009;34:1078–93.
26. Manchikanti L, Singh V, Falco FJE, Cash KA, Pampati V. Lumbar facet joint nerve blocks in managing chronic facet joint pain: one-year follow-up of a randomized, double-blind controlled trial—Clinical Trial NCT00355914. Pain Physician. 2008;11:121–32.
27. Hansen HC, McKenzie-Brown AM, Cohen SP, Swicegood JR, Colson JD, Manchikanti L. Sacroiliac joint interventions: a systematic review. Pain Physician. 2007;10:165–84.
28. Liliang PC, Lu K, Weng HC, Liang CL, Tsai YD, Chen HJ. The therapeutic efficacy of sacroiliac joint blocks with triamcinolone acetonide in the treatment of sacroiliac joint dysfunction without spondyloarthropathy. Spine. 2009;34:896–900.
29. Borowsky CD, Fagen G. Sources of sacroiliac region pain: insights gained from a study comparing standard intra-articular injection with a technique combining intra- and peri-articular injection. Arch Phys Med Rehabil. 2008;89:2048–56.
30. Manchikanti L, Singh V, Falco FJE, Cash KM, Fellows B. Cervical medial branch blocks for chronic cervical facet joint pain: a randomized, double-blind, controlled trial with one-year follow-up. Spine. 2008;33:1813–20.
31. Ward ST, Williams PL, Purkayastha S. Intra-articular corticosteroid injections in the foot and ankle: a prospective 1-year follow-up investigation. J Foot Ankle Surg. 2008;47:138–44.
32. Hartrick CT. Quality assessment in clinical trials: considerations for outcomes research in interventional pain medicine. Pain Pract. 2008;8:433–8.
33. Bolton JE. Sensitivity and specificity of outcome measures in patients with neck pain: detecting clinically significant improvement. Spine. 2004;29:2410–7.
34. Bolton JE. The evidence in evidence-based practice: What counts and what doesn't count? J Manip Physiol Ther. 2001;24:362–6.