

## Review

## A Systematic Review of Therapeutic Facet Joint Interventions in Chronic Spinal Pain

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**Background:** Facet joints are considered to be a common source of chronic spinal pain. Facet joint interventions, including intraarticular injections, medial branch nerve blocks, and neurotomy (radiofrequency and cryoneurolysis) are used to manage chronic facet-mediated spinal pain. A systematic review of therapeutic facet interventions published in January 2005, concluded that facet interventions were variably effective for short-term and long-term relief of facet joint pain.

**Objective:** To provide an updated evaluation of the effectiveness of 3 types of facet joint interventions in managing chronic spinal pain.

**Study Design:** A systematic review utilizing criteria established by the Agency for Healthcare Research and Quality (AHRQ) for evaluation of randomized and non-randomized trials and the Cochrane Musculoskeletal Review Group for randomized trials.

**Methods:** Data sources included relevant literature of the English language identified through searches of MEDLINE and EMBASE (November 2004 to December 2006) and manual searches of bibliographies of known primary and review articles within the last 2 years. Results of the analyses were performed for the different modes of facet joint interventions for the cervical, thoracic and lumbar spine, to determine short- and long-term outcome measurements and complications associated with these procedures.

**Outcome Measures:** The primary outcome measure was pain relief. For intraarticular facet joint injections and medial branch blocks, short-term pain relief was defined as relief lasting less than 6 weeks and long-term relief as 6 weeks or longer. For medial branch blocks, repeated injections at defined intervals provided long-term pain relief. For medial branch radiofrequency neurotomy, short-term pain relief was defined as relief lasting less than 3 months and long-term relief as lasting 3 months or longer. Other outcome measures included functional improvement, improvement of psychological status, and return to work.

**Results:** For cervical intraarticular facet joint injections, the evidence is limited for short- and long-term pain relief. For lumbar intraarticular facet joint injections, the evidence is moderate for short- and long-term pain relief. For cervical, thoracic, and lumbar medial branch nerve blocks with local anesthetics (with or without steroids), the evidence is moderate for short- and long-term pain relief with repeat interventions. The evidence for pain relief with radiofrequency neurotomy of cervical and lumbar medial branch nerves is moderate for short- and long-term pain relief, and indeterminate for thoracic facet neurotomy.

**Conclusion:** With intraarticular facet joint injections, the evidence for short- and long-term pain relief is limited for cervical pain and moderate for lumbar pain. For medial branch blocks, the evidence is moderate for short- and long-term pain relief. For medial branch neurotomy, the evidence is moderate for short- and long-term pain relief.

**Key words:** Spinal pain, neck pain, low back pain, facet or zygapophysial joints, intraarticular facet joint injections, medial branch blocks, therapeutic medial branch blocks, radiofrequency neurotomy, cryodestruction.

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**F**acet or zygapophysial joints are considered to be common sources of chronic spinal pain (1,2). In addition to causing localized spinal pain, facet joints may refer pain to adjacent structures. Cervical facet joint pain may radiate to the head, neck, and shoulders. Thoracic facets may produce paraspinal mid-back pain with neuralgic characteristics; and lumbar facet joints may refer pain to the back, buttocks, and proximal lower extremities. Referred pain may assume a pseudoradicular pattern, making the underlying diagnosis difficult to confirm, without the use of diagnostic blocks (1,2).

Facet joints are a well-recognized source of pain in subjects with persistent spinal pain (2). Spinal facet joints have been shown to be a source of pain in the neck and referred pain in the head and upper extremities (3-7); upper back, mid-back, and referred pain in the chest wall (8,9); and the low back and referred pain in the lower extremity (10-15). Facet joints are well innervated by the medial branches of the dorsal rami (16-35). Neuroanatomic, neurophysiologic, and biomechanical studies have demonstrated free and encapsulated nerve endings in facet joints, as well as nerves containing substance P calcitonin gene-related peptide (35-50); facet joint capsules contain low-threshold mechanoreceptors, mechanically sensitive nociceptors and silent nociceptors, (35-53); and lumbar and cervical facet joint capsules can undergo high strains during spine loading (35,54-65).

Consistent with criteria established by the International Association for the Study of Pain (66), facet joints may be a source of chronic pain in 15% to 45% of patients with chronic low back pain (67-80); 36% to 60% of the patients with chronic neck pain (68,69,77-79,81-86); and 34% to 48% of the patients with thoracic pain (78,79,87).

Facet joint pain may be managed by intraarticular injections, medial branch blocks, and neurolysis of medial branch nerves. However, conflicting results have been reported for the value of the different treatment modalities in systematic and narrative reviews (88-94). A recent narrative review by Bogduk (94) suggested that intraarticular facet joint injections were no better than placebo for chronic lumbar spine pain. Slipman et al (92), in a review of the evidence for the use of zygapophysial injections and radiofrequency denervation in the treatment of low back pain, found limited evidence for intraarticular injections in the lumbar spine and moderate evidence for radiofrequency neurotomy in the lumbar spine. Boswell et al

(1), in a systematic review of therapeutic facet joint interventions for 3 regions of the spine, showed moderate evidence for lumbar intraarticular facet joint injections for short-term improvement, but only limited evidence for long-term improvement. The evidence was negative for cervical intraarticular facet joint injections. The evidence was moderate for cervical and lumbar medial branch blocks with local anesthetics and steroids. The evidence for pain relief with radiofrequency neurotomy of medial branch nerves was moderate to strong for cervical and lumbar regions.

European guidelines for the management of chronic nonspecific low back pain (90), utilizing the evidence available from January 1995 to November 2002, concluded that intraarticular facet joint injections were ineffective in managing chronic low back pain. In this limited literature review, they showed no significant effectiveness of medial branch blocks. The European guidelines concluded that there was conflicting evidence that radiofrequency denervation of the facet joints is more successful than placebo for eliciting short-term or long-term improvements in pain or functional disability in mechanical chronic low back pain. They also indicated that there was limited evidence that intraarticular denervation of the facet joints is more effective than extraarticular denervation. Geurts et al (88) concluded that there was moderate evidence that radiofrequency lumbar facet denervation was more effective for chronic low back pain than placebo, and there was only limited evidence for effectiveness of radiofrequency neurotomy for chronic cervical zygapophysial joint pain after flexion/extension injury. However, Geurts et al (88) included both medial branch neurotomy and intraarticular neurotomy in their evaluation, along with dorsal root denervation. Manchikanti et al (91) evaluated medial branch neurotomy for the management of chronic spinal pain utilizing the Agency for Healthcare Research and Quality (AHRQ) criteria with inclusion of randomized and observational reports, and concluded that there was strong evidence for short-term relief and moderate evidence for long-term relief of facet joint pain. Niemisto et al (89), in a systematic review of radiofrequency denervation for neck and back pain within the framework of Cochrane Collaboration Back Review Group, concluded that there was limited evidence that radiofrequency denervation had a positive short-term effect on chronic cervical zygapophysial joint pain, and a conflicting short-term effect on chronic low back pain.

Although there have not been reviews on the therapeutic effectiveness of facet interventions in the past 2 years, there have been several randomized and observational studies of therapeutic interventions.

This systematic review was undertaken to update the effectiveness of intraarticular facet joint blocks, medial branch blocks, and medial branch radiofrequency denervation in the treatment of chronic spinal pain of facet joint origin.

## **METHODS**

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### **Literature Search**

The literature search included MEDLINE and EMBASE (November 2004 – December 2006), Cochrane database, systematic reviews, narrative reviews, cross-references to the reviews and various published trials, and peer-reviewed abstracts from scientific meetings during the past 2 years, published in the English language. The same search strategy was also performed using the Google search engine. The search strategy consisted of facet (zygapophysial joint) injections with local anesthetics and steroids, medial branch facet nerve blocks with local anesthetics and steroids, medial branch (facet nerve) nerve blocks, and radiofrequency neurotomy or cryoneurolysis. The emphasis of the analysis was on chronic spinal pain of facet joint origin.

#### *Selection Criteria and Data Extraction*

This review evaluated randomized and observational studies and reports of complications. To be included in this review, studies should have documented the existence of spinal pain of facet origin using controlled diagnostic facet joint or nerve blocks. However, due to the scarcity of such studies, studies with single blocks were also considered.

Three types of facet interventions were included in this review: intraarticular facet joint injections, medial branch blocks, and medial branch radiofrequency neurotomy, cryoneurolysis, and other neurolytic techniques. All studies providing appropriate management with outcome evaluations of at least 3 months and statistical analysis were reviewed. The primary outcome measure was pain relief at various time points. The secondary outcome measures were functional or psychological improvement, return to work, and complications. Principles of evidence synthesis in interventional pain management for interventional techniques has been described (95,96). For this systematic review, the same principles utilized in

the previous systematic review (1) were used.

For evaluating the quality of individual articles, we used the criteria from AHRQ (97). For inclusion, studies must have met at least 50% of the key domains and elements. Criteria described by the Cochrane Review Group for Musculoskeletal Disorders (98) were also used for evaluation of randomized trials.

Each study was evaluated for inclusion criteria, the study population, outcomes data, and statistical analysis (99). Parameters and criteria are described elsewhere (1,96).

### **Analysis of Evidence**

Qualitative analysis was conducted using five levels of evidence for effectiveness as illustrated in Table 1. For intraarticular injections and medial branch blocks, pain relief was evaluated for short-term (< 6 weeks) and long-term (6 weeks or longer) benefit. For neurolytic interventions, short-term relief pain relief was considered to be <3 months duration and ≥3 months for long-term benefit.

For randomized trials, a study was judged to be positive if the facet joint intervention was more effective than the reference treatment. For observational studies, results were considered positive if the treatment was effective by defined criteria (e.g., >50% pain relief) for the designated period of time. All other conclusions were considered negative. If, in the opinion of the reviewers there were inconsistencies in the conclusions, disagreements were resolved by discussion and consensus.

## **RESULTS**

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### **Intraarticular Facet Joint Blocks**

Our search strategy ([facet or zygapophysial] AND injection) identified 44 new references; 2 studies met inclusion criteria for the present review (100,103). The search performed for our previous systematic review identified a total of 235 articles, with 10 relevant articles for further review (104-113).

#### *Methodological Quality*

Five randomized studies of intraarticular lumbar steroid facet joint injections (100,104-107) and 1 randomized study of the cervical spine (108) compared results to those of similar groups not receiving intraarticular steroids. Of these, Fuchs et al (100), Carrette et al (104), and Barnsley et al (108) met inclusion criteria (Table 2).

Other randomized trials by Lilius et al (105), Marks

Table 1. Designation of levels of evidence.

<b>Level I</b>	Conclusive: Research-based evidence with multiple relevant and high-quality scientific studies or consistent reviews of meta-analyses.
<b>Level II</b>	Strong: Research-based evidence from at least 1 properly designed randomized, controlled trial; or research-based evidence from multiple properly designed studies of smaller size; or multiple low quality trials.
<b>Level III</b>	Moderate: a) Evidence obtained from well-designed pseudorandomized controlled trials (alternate allocation or some other method); b) Evidence obtained from comparative studies with concurrent controls and allocation not randomized (cohort studies, case-controlled studies, or interrupted time series with a control group); c) Evidence obtained from comparative studies with historical control, 2 or more single-arm studies, or interrupted time series without a parallel control group.
<b>Level IV</b>	Limited: Evidence from well-designed nonexperimental studies from more than 1 center or research group; or conflicting evidence with inconsistent findings in multiple trials.
<b>Level V</b>	Indeterminate: Opinions of respected authorities, based on clinical evidence, descriptive studies, or reports of expert committees.

Adapted from refs 1,95,96

et al (106), and Nash (107) did not meet inclusion criteria and were excluded. Marks et al (106) and Nash (107) compared the effects of intraarticular injections with medial branch blocks. Even though the number of patients included was of clinical significance with 86 and 67, respectively, patient selection failed to include controlled diagnostic blocks, there was not a blinded evaluation by an independent observer, and the authors utilized poor assessment tools. Lilius et al (105) included patients with neurological deficits, failed to confirm the diagnosis, and used excessive volumes (3 mL to 8 mL) of active agents.

Among the observational reports, 7 studies (103, 109-115) met inclusion criteria. Six prospective (103, 109-111,114,115) and 2 retrospective evaluations were included (112,113). Of these, 4 prospective studies evaluated low back pain (109-111,114), 2 prospective evaluations were performed in the neck (103,115) and 2 retrospective evaluations evaluated chronic low back pain (112,113).

Gorbach et al (101) evaluated 42 consecutive patients meeting diagnostic criteria for lumbar facet syndrome by history or examination, but performed intraarticular facet joint injections on one occasion, under fluoroscopic guidance. This study was excluded from further analysis in the present review due to only

a 3-month follow-up.

Shih and colleagues (102) reported the results of lumbar intraarticular facet joint injections in a prospective study of 277 patients with low back pain. Following injections of lidocaine, betamethasone, and contrast, positive responses (VAS < 5) were noted in 72.1% (147/204) of patients after 3 weeks, 40.7% (83/204) after 6 weeks, and 31.4% (64/204) after 12 weeks. The injections were done for diagnostic purposes and the authors noted modest pain relief as described above. However, since the study was designed primarily to test the diagnostic value and clinical benefit of intraarticular injections and because follow-up was limited to 3 months, the study was excluded from further analysis.

#### Study Characteristics

Three randomized studies, those by Fuchs et al (100) and Carette et al (104) involving lumbar facet joint injections, and by Barnsley et al (108) involving cervical facet joint injections, are considered high quality and have been used in the evidence synthesis. Details of these randomized trials are shown in Table 2. Even though methodological criteria for both the above studies were considered optimal, Carette et al (104) failed to exclude placebo responders, which may account for the relatively high incidence of pa-

Table 2. Characteristics of published randomized trials of intraarticular facet joint injections.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 6 wks Long-term relief ≥ 6 wks
<b>Lumbar Spine</b>					
Fuchs et al (100) Lumbar facet joint injections Randomized, controlled, blind observer, clinical study AHRQ score: 9/10 Cochrane score: 9/10	60 patients with chronic non-radicular lumbar pain. Patients were randomly assigned to 2 groups to receive 10 mg of sodium hyaluronate (SH) or 10 mg of triamcinolone acetoneide; TA.	The facet joints on both sides at levels L3/4, L4/5, and L5/S1 were treated once per week under computed tomographic guidance, with 10 mg of sodium hyaluronate, or 10 mg of triamcinolone acetoneide.	Follow-up: 3 and 6 months outcome parameters: visual analog scale, Roland Morris questionnaire, Oswestry Disability questionnaire, Low Back Outcome Score, Short Form 36 questionnaire.	Significant pain relief and improved function and quality of life were observed with both treatments. The study results were positive for both hyaluronate and glucocorticoid injections.	Positive short-term and long-term relief
Carrette et al (104) Lumbar facet joint injections Randomized, double-blind, placebo-controlled trial AHRQ score: 10/10 Cochrane score: 10/10	190 patients entered Phase I of the study. Of these, 110 (58%) reported a reduction of 50% or more in their pain after the injections of lidocaine. 101 patients entered the randomized trial (Phase II), 51 in the methylprednisolone group, and 50 in the placebo group.	The patients received injections of either 20 mg (1 mL) of methylprednisolone acetate mixed with 1 mL of isotonic saline or 2 mL of isotonic saline in each of the facet joints. All the injections were preceded by arthrography and were performed under fluoroscopic guidance.	95 patients of 101 were followed for 6 months and their condition assessed with scales of pain severity, back mobility, and limitation of function.	42% of the patients who received methylprednisolone and 33% of those who received placebo reported marked or very marked improvement with no significant difference among the groups at 3 months (versus 15% control group); at 6 months increased to 46%, with statistically significant difference (p = 0.002).	Negative short-term and long-term relief
<b>Cervical Spine</b>					
Barnsley et al (108) Cervical facet joint injections Randomized, double-blind AHRQ score: 10/10 Cochrane score: 9/10	41 patients with cervical pain after whiplash and with relief of pain after controlled diagnostic blocks randomized to intraarticular steroid or local anesthetic cervical facet joint injections.	Patients randomized to intraarticular injection of 5.7 mg betamethasone or 1ml intraarticular bupivacaine.	Return of pain to 50% of preinjection pain level.	No significant difference in duration of pain relief. Median duration of time to return of pain to 50% was 3 days in the steroid group and 3.5 days in the local anesthetic group.	Negative short-term and long-term relief

tients in their study with presumed facet joint pain. They showed a prevalence of lumbar facet joint pain of 58% in patients with spine pain, based on inclusion criteria in Phase I of the study. Failure to exclude placebo responders may have diluted the findings of true responses, making detection of differences between the study and control groups difficult. Further, even though results were judged to be positive at 6 months in the methylprednisolone group, they performed various types of analyses and finally concluded that there

was no significant difference between groups.

Fuchs et al (100) investigated the efficacy and safety of intraarticular sodium hyaluronate (SH) compared with intraarticular glucocorticoids (triamcinolone acetoneide; TA) in the treatment of chronic nonradicular lumbar pain. They included 60 patients in this randomized, controlled, blind-observer clinical study and randomly assigned to 2 groups to receive 10 mg of SH or 10 mg TA per facet joint. The facet joints on both sides at levels L3/4, L4/5, and L5/S1 were treated once

per week under computed tomographic guidance for a total of 6 injections. Outcome parameters included a visual analog scale, Roland Morris questionnaire, Oswestry Disability questionnaire, the Low Back Outcome Score, and the Short Form 36 questionnaire. The results showed significant pain relief and improved function and quality of life with both treatments. However, this study also showed that intraarticular hyaluronate was equivalent to intraarticular steroid. The follow-up was carried out at 3 and 6 months after completion of treatment; thus, this was considered a positive study for both hyaluronic acid and steroid injections. The drawbacks of this study include lack of diagnosis of facet joint pain by controlled local anesthetic blocks which may have increased the probability of inclusion of patients without facet joint pain.

Barnsley et al (108) performed a well-conducted study, but faced criticism. They included a total of 41 patients whose origin of neck pain was posttraumatic, following whiplash. Consequently, results may not be extrapolated to treatment of patients with cervical facet joint pain from nontraumatic causes, because responses to intraarticular steroid injections is not known for cervical facet joint pain of spontaneous origin.

Kim et al (103) was included as a new prospective observational study. They classified patients with zygapophysial joint pain of C5/6 and C6/7 and treated with therapeutic cervical facet joint injections with a mixture of 0.5 mL of 1% lidocaine with 5 mg of triamcinolone under fluoroscopy. They classified patients into a herniated nucleus pulposus group, myofascial pain syndrome group, and whiplash-associated disorders group. The therapeutic effects included reduction of numeric rating scale (NRS) of pain before and immediately after blockade and symptom-free periods after 12 months. The NRS scores decreased immediately after the blockade and the symptom-free duration after blockade lasted longer in the herniated nucleus pulposus group ( $11.3 \pm 1.7$  months) as compared to the myofascial pain syndrome group ( $3.2 \pm 0.9$  months) and the whiplash-associated disorders group ( $3.0 \pm 0.8$  months). Characteristics and results of observational studies of intraarticular facet joint injections are illustrated in Table 3 along with methodological scores.

Schulte et al (114) evaluated 39 patients with lumbar facet syndrome using a standardized protocol with injection of steroid, lidocaine, and 5% phenol under fluoroscopic control, evaluated on follow-up using

a specially designed questionnaire, which included McNab criteria, visual analogue scale, and pain disability index. They reported pain relief up to 6 months after treatment and the outcome was assessed excellent or good by 62% (24 patients) of the patients after one month, by 41% (16 patients) after 3 months, and by 36% (14 patients) after 6 months. They concluded that facet joint injection therapy using a standardized protocol is safe, effective, and easy to perform. Several disadvantages of this study included lack of appropriate diagnosis of facet joint pain by controlled local anesthetic blocks, possibly including false-positive patients, and injecting phenol with steroid. A combination of phenol and steroid has not been recommended as phenol may be injected to induce inflammation whereas prednisolone suppresses inflammation. However, the results were positive with 62% of patients reporting excellent or good pain relief after 1 month with a single block which extended to 36% of patients after 6 months.

Folman et al (115) evaluated the effectiveness of zygapophysial joint injections on chronic cervical pain. They selected 30 patients, with pain of more than 12 months duration and with no history of trauma, after confirming the diagnosis with intraarticular, fluoroscopically-guided injections of local anesthetic. The patients were subsequently treated with intraarticular depo-methylprednisolone. Pain relief was assessed by visual analog scale. The mean time for relapse of 50% of the pre-injection level of pain was  $12.47 \pm 1.89$  weeks. They concluded that selective intraarticular blockade of the facet joints may be offered as an adjuvant for diagnostic and therapeutic purposes for patients with chronic pain due to facet arthrosis in the ambulatory setting. Their results were superior to the relief of 3 days reported in patients similarly treated following whiplash neck injury; however, the study failed to include comparative local anesthetic blocks, additional outcome parameters, and long-term follow-up.

Lynch and Taylor (111) reported initial pain relief in 31 of 35 patients receiving intraarticular steroids, whereas 8 of 15 patients receiving extraarticular steroids reported initial pain relief. Long-term pain relief was reported in 62% at 3 months, and 56% at 6 months. Destouet et al (110) reported significant pain relief for 1 to 3 months in 54% of the patients and 3 to 6 months in 38% of the 54 patients. Murtagh (109) reported long-term relief of up to 6 months in 54% of the 100 patients. Among the retrospective evalu-

ations, Lippitt (112) reported greater than 50% relief initially in 42% of patients, which declined to 14% at 6 months and 8% at 12 months in 99 patients. Lau et al (113) also reported initial relief in 56% of the patients, which declined to 44% at 3 months, and 35% at 6 to 12 months. Thus, all the observational studies showed positive results.

### **Effectiveness**

The results of the study by Carette et al (104) were negative at 6 months, although patients who received intraarticular methylprednisolone were considerably improved compared to the control group. Notwithstanding their suggestion that concurrent treatments may have influenced the outcomes, for purposes of this systematic review, in terms of pain relief following intraarticular facet joint injections, the outcome is considered to have been positive for lumbar facet pain at 6 months. Fuchs et al (100) showed significant pain relief, improved function, and improved quality of life with intraarticular sodium hyaluronidase and intraarticular glucocorticoids at 3 and 6 months after injections. Barnsley et al (108) reported negative results with cervical intraarticular injections of steroids and local anesthetic.

Among the nonrandomized trials, 6 prospective evaluations (103,109-111,114,115) and 2 retrospective evaluations (112,113) met inclusion criteria. Among the prospective trials included in the evidence synthesis, Kim et al (103) reported positive short-term and long-term relief with cervical intraarticular injections performed under fluoroscopy. Folman et al (115) also evaluated the effectiveness of facet joint injections on chronic neck pain of nontraumatic origin and noted positive short-term and negative long-term results. Schulte et al (114) reported positive results with intraarticular injections of steroid, lidocaine, and 5% phenol under fluoroscopic control. Lynch and Taylor (111) reported initial pain relief in 31 of 35 patients receiving intraarticular steroids, whereas 8 of the 15 patients receiving extraarticular steroids reported pain relief. Long-term relief was reported in 62% at 3 months and 56% at 6 months. Destouet et al (110) reported significant pain relief for 1 to 3 months in 54% of the patients and for 3 to 6 months in 38% of the patients. Murtagh (109) reported long-term relief of longer than 3 months in 54% of patients, although a large fraction of the patients included had nonspecific back pain or radicular symptom. Among the retrospective evaluations, Lippitt (112) reported greater than 50% relief initially in 42%

of patients, which declined to 14% at 6 months and 8% at 12 months. Lau et al (113) reported initial relief in 56% of patients, which declined to 44% at 3 months, and 35% at 6 to 12 months.

### **Cost Effectiveness**

No studies were performed evaluating cost effectiveness of therapeutic intraarticular facet joint injections.

### **Level of Evidence**

For intraarticular injections of local anesthetics and steroids, there is moderate evidence for short- and long-term improvement in low back pain. The evidence is limited for short- and long-term improvement in neck pain.

### **Medial Branch Blocks**

Our search strategy ([facet or zygapophysial] AND injection AND nerve blocks) identified 27 new references, of which 3 evaluated therapeutic medial branch blocks; 2 randomized trials (116,117), and a prospective study (118). The previous systematic review identified 6 relevant articles, 4 of which were randomized clinical trials (106,107,119,120) and 2 nonrandomized clinical trials (121,122).

### **Methodologic Quality**

Three new studies (116-118) met criteria for inclusion in the current analysis. In addition, 2 studies (119,121) that met inclusion criteria in the previous systematic review are included in the current evidence synthesis.

Overall, 5 randomized studies met inclusion criteria (106,107,116,117,119). However, Marks et al (106) and Nash (107) were excluded as they compared the effectiveness of intraarticular injections with medial branch blocks on a short-term basis with no controlled local anesthetic blocks, and with lack of long-term follow-up and outcomes. Other studies excluded were a study by Manchikanti et al (122) examining the diagnostic validity of lumbar facet joint pain by controlled, comparative local anesthetic blocks, and a second study by Manchikanti et al (120) evaluating the effect of Sarapin.

Three randomized trials were included in the evidence synthesis (116,117,119). In addition, both prospective evaluations (118,121) were included. Table 4 illustrates characteristics of published reports of cervical, thoracic and lumbar medial branch blocks included in the evidence synthesis.

Table 3. Characteristics and results of observational studies of cervical and lumbar facet joint injections.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 6 wks Long-term relief ≥ 6 wks
<b>Cervical</b>					
Kim et al (103) Prospective evaluation AHRQ score: 4/8	60 patients were treated with therapeutic cervical zygapophysial joint injections under fluoroscopy. Patients were divided into 3 groups: herniated nucleus pulposus group, myofascial pain syndrome group, and whiplash-associated disorders group.	Intraarticular injection of 1% lidocaine with 5 mg of triamcinolone under fluoroscopy into C5/6 and C6/7 joints.	Pain relief and duration of symptom-free period	The symptom-free duration after blockade lasted longer in the herniated nucleus pulposus group with $11.3 \pm 1.7$ months than the other 2 groups. In the myofascial pain syndrome group, relief was $3.2 \pm 0.9$ months and in whiplash-associated disorders group, the relief was $3.0 \pm 0.8$ months.	Positive short-term and long-term relief
Folman et al (115) Prospective evaluation AHRQ score: 4/8	30 patients, with pain of more than 12 months duration and with no history of trauma, with facet joint pain diagnosed by intraarticular fluoroscopically-guided infiltration of anesthetic.	Following the diagnosis of facet joint pain with intraarticular, fluoroscopically-guided local anesthetic injections, treated with intraarticular corticosteroids depo-medrol 40 mg.	Pain relief assessed by visual analog scale.	The mean time for relapse of 50% of the preinjection level of pain was $12.47 \pm 1.89$ weeks.	Positive short-term and long-term relief.
<b>Lumbar</b>					
Schulte et al (114) Prospective evaluation AHRQ score: 6/8	39 patients with chronic low back pain diagnosed as lumbar facet syndrome.	Injection of steroid, lidocaine, and 5% phenol under fluoroscopic control.	Outcomes were determined on a follow-up based specialty questionnaire including: visual analog scale, McNab criteria, and pain disability index.	Pain relief of up to 6 months was reported after the treatment. The outcome was assessed as excellent or good by 62% of the patients after 1 month, by 41 after 3 months, and 36 after 6 months.	Positive short-term and negative long-term relief
Murtagh (109) Prospective study AHRQ score: 6/8	100 patients with low back pain with pain relief after lumbar intraarticular facet joint injections using fluoroscopy or CT.	Patients with immediate relief of pain after local anesthetic injections received repeat intraarticular injection of 6 mg betamethasone.	Follow-up in all patients. Subjective relief as determined by patient response.	54% of patients had more than 3 months of pain relief.	Positive short-term and long-term relief
Destouet et al (110) Prospective study AHRQ score: 6/8	54 patients studied; 13 had previous lumbar surgery. Patients received intraarticular facet injections.	1 ml 0.25% bupivacaine and 40 mg depot methylprednisolone.	Pain relief.	54% of patients had initial relief; whereas 38% had continued pain relief for 3 months or longer.	Positive short-term and negative long-term relief



Table 3 Continued. *Characteristics and results of observational studies of cervical and lumbar facet joint injections.*

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 6 wks Long-term relief ≥ 6 wks
Lynch and Taylor (111) Prospective study AHRQ score: 6/8	35 patients in intraarticular and 15 in extraarticular group, all with presumed lumbar facet pain, were studied.	Intraarticular or extraarticular injections with 60 mg methylprednisolone.	Pain relief.	89% of patients had pain relief initially in the intraarticular group; intraarticular injections were better than extraarticular.	Positive short-term and long-term relief
Lippitt (112) Retrospective review AHRQ score: 5/8	99 patients with clinical diagnosis of lumbar facet pain received facet joint injections with fluoroscopy.	Intraarticular injection of 1 ml 1% lidocaine and 80 mg depot methylprednisolone.	Pain relief, return to work.	42% of patients had initial relief which declined to 14% at 6 months.	Negative short-term and long-term relief
Lau et al (113) Retrospective study AHRQ score: 6/8	34 consecutive patients with clinical diagnosis of lumbar facet pain received facet joint injections with fluoroscopy.	Intraarticular injection of bupivacaine and depot methylprednisolone.	Pain relief.	56% of patients reported immediate pain relief, which declined to 44% at 3 months and 35% at 6 to 12 months.	Positive short-term and negative long-term relief

### Study Characteristics and Effectiveness

Three new studies evaluated the effectiveness of medial branch blocks for managing chronic spinal pain of facet origin. Manchikanti et al (116) evaluated pain relief with cervical medial branch blocks in a randomized, double-blind, controlled trial of patients with chronic neck pain. In their preliminary report, the authors describe 60 patients with cervical facet pain diagnosed by comparative, controlled diagnostic cervical facet medial branch nerve blocks with bupivacaine, with or without steroid (betamethasone). Significant pain relief (> 50%) and improvement in functional status were observed at 3, 6, and 12 months in 80%-87%, 80%-93%, and 87%-93% of patients, respectively. The average number of treatments per patient for 1 year was about 3.5, with no difference between the groups. Duration of relief was approximately 3.5 months per treatment. Thus, satisfactory relief of chronic spinal pain of facet origin could be maintained over the course of a year with medial branch blocks repeated at clinically indicated intervals. Inclusion of steroid in the injectate did not appear to provide additional benefit. Although this was a small, randomized study, it provides further evidence that cervical facet joint medial

branch blocks may offer durable relief of facet pain without neurolysis.

A second preliminary report by Manchikanti et al (117) is in press and was obtained for the current review. The study is a randomized, double-blind, controlled trial similar in design to the study described above (116). Sixty patients with lumbar facet pain diagnosed with comparative local anesthetic medial branch blocks were randomized to receive therapeutic local anesthetic medial branch blocks of lumbar facets, with or with steroid (betamethasone). Results were similar to those described for cervical facet pain. Significant pain relief and functional status improvement were observed at 3 months, 6 months, and 12 months, compared to baseline measurements, in 73%-87%, 87%-93%, and 73%-93% of patients, respectively. The average number of treatments per patient for 1 year was approximately 3.5, with no significant differences noted between groups. Duration of average pain relief with each procedure was about 3.5 months. This small, randomized study provides additional evidence that medial branch blocks may be considered therapeutic for patients with chronic low back pain of facet origin.

Table 4. Characteristics of published reports of cervical, thoracic, and lumbar medial branch blocks.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 3 mos Long-term relief ≥ 3 mos
<b>CERVICAL</b>					
Manchikanti et al (116) Cervical medial branch nerve blocks Randomized, double-blind controlled AHRQ score: 7/10 Cochrane score: 10/10	60 patients, all meeting criteria for cervical facet joint pain. 4 treatment groups, 15 patients each.	Cervical medial branch nerve blocks in all 4 treatment groups: Group I serving as control with bupivacaine only; Group II with bupivacaine+sarapin; Group III with bupivacaine+betamethasone; Group IV with bupivacaine+sarapin+betamethasone.	Measured numeric pain scores, Neck Pain index, opioid intake, and employment status at baseline, 3, 6, and 12 mos.	Significant pain relief (≥50%) and functional status improved at 3, 6, and 12 mos. No significant difference in the duration of average pain relief among the groups. 80%-93% of patients reported significant relief at 3, 6 and 12 mos.	Positive short-term and long-term relief
Manchikanti et al (121) Cervical medial branch blocks Prospective AHRQ score: 8/8	100 consecutive patients with cervical facet pain diagnosed by comparative, controlled local anesthetic blocks.	Medial branch blocks with fluoroscopy with bupivacaine with or without methylprednisolone. Patients had repeat blocks as clinically indicated.	Pain relief Oswestry Disability Index, psychological status, work status Timings: 3 mos, 6 mos, and 12 mos.	Significant pain relief at 3, 6, and 12 mos, compared to baseline measurements. There was also significant improvement in disability status, psychological status, and return to work. Significant pain relief was observed at 92% at 3 mos, 82% at 6 mos, and 56% at 12 mos.	Positive short-term and long-term relief
<b>THORACIC</b>					
Manchikanti et al (118) Thoracic medial branch nerve blocks Prospective outcome study AHRQ score: 8/10	55 consecutive patients, all meeting diagnostic criteria for thoracic facet joint pain.	Thoracic facet joint nerve blocks performed using bupivacaine with or without Sarapin and dexamethasone.	Measured numeric pain scores, Oswestry Disability Index, employment status, and Pain Patient Profile at 3, 6, 12, 24, and 36 mos.	Significant (≥50%), was observed in 71% of the patients at 3 mos and 6 mos, 76% at 12 mos, 71% at 24 mos, and 69% at 36 mos.	Positive short-term and long-term relief
<b>LUMBAR</b>					
Manchikanti et al (117) Lumbar facet joint nerve blocks Prospective, randomized, double-blind controlled AHRQ score: 8/10 Cochrane score: 8/10	60 patients, all meeting diagnostic criteria for lumbar facet joint pain. 4 treatment groups, 15 patients each.	Lumbar facet joint nerve block injections in all 4 treatment groups: Group I serving as control with bupivacaine only; Group II with bupivacaine+sarapin; Group III with bupivacaine+steroid; Group IV with bupivacaine+sarapin+steroid	Measured numeric pain scores, Oswestry Disability Index, opioid intake, and employment status at baseline, 3, 6, and 12 mos.	Significant pain relief (≥50%) and functional status improved at 3, 6, and 12 mos. No significant differences noted between steroid and nonsteroid treatment groups. 73%-93% of patients reported significant relief at 3, 6, and 12 mos.	Positive short-term and long-term relief
Manchikanti et al (119) Lumbar medial branch blocks Randomized, controlled trial AHRQ score: 8/10 Cochrane score: 6/10	200 patients with low back pain were evaluated. 73 patients were enrolled in study after confirmation of facet pain by controlled diagnostic facet nerve blocks.	Medial branch blocks with fluoroscopy. Patients randomized into 2 groups: local anesthetic, bupivacaine, with or without Sarapin®. Patients had repeat procedures as clinically indicated.	Outcomes were evaluated over a period of 2½ years. Measurements were performed at 1, 3, 6, 12, 18, 24, and 32 mos. Outcomes included pain relief, physical health, psychological status, narcotic intake, and employment status.	Cumulative significant relief with 1 to 3 injections up to 2.5 years. Overall, significant relief for a mean of 6.5 mos. Significant improvement was noted in overall health status with improvement in pain relief, psychological status, and return to work status. Significant relief was seen with 1 to 3 injections in 100% of patients at 3 mos, 75%-88% at 6 mos, and 17%-25% at 12 mos.	Positive short-term and long-term relief

An observational study by Manchikanti and colleagues (118) examined the therapeutic benefit of thoracic medial branch blocks in a prospective outcome study. In 55 consecutive patients with thoracic facet pain confirmed by comparative diagnostic facet nerve blocks, more than two-thirds of patients obtained significant pain relief (> 50%) with bupivacaine and methylprednisolone compared to baseline measurements, (71% of the patients at 3 months and 6 months, 76% of the patients at 12 months, 71% at 24 months, and 69% at 36 months). Patients received approximately 3 to 4 blocks per year with an average duration of relief per treatment of about 4 months. As with the cervical and lumbar facet nerve block studies (*vide supra*), this article provides evidence that repetitive medial branch blocks may provide durable relief of spinal pain of thoracic facet joint origin.

Manchikanti et al (119) evaluated 73 patients positive for lumbar facet joint pain by means of controlled, comparative local anesthetic blocks. They randomly allocated patients into 2 groups, either therapeutic medial branch blocks with a local anesthetic and Sarapin or a mixture of local anesthetic, Sarapin, and methylprednisolone. Significant improvement was documented in both groups in various parameters of pain relief, functional status, opioid intake, return to work, and psychological status. Significant cumulative pain relief was seen with 1 to 3 injections in 100% of the patients up to 1 to 3 months, 82% of the patients for 4 to 6 months, and 21% for 7 to 12 months. The mean relief was  $6.5 \pm 0.76$  months.

Manchikanti et al (121) evaluated the therapeutic effectiveness of cervical facet joint nerve blocks in chronic neck pain in a prospective outcome study. They evaluated 100 consecutive patients meeting the diagnostic criteria of facet joint pain by means of comparative, controlled diagnostic blocks. There were significant differences in numeric pain scores and pain relief (> 50%) at 3 months (92%), 6 months (82%), and 12 months (56%) compared to baseline measurements. There was significant improvement in functional status, psychological status, and employment among patients eligible for employment (employed and unemployed) from baseline to 12 months.

Manchikanti et al (118) in a prospective outcome study with minimum of 1-year follow-up, evaluated the therapeutic role of thoracic medial branch blocks in managing chronic thoracic pain. Fifty-five consecutive patients meeting the diagnostic criteria of thoracic facet joint pain by means of comparative, controlled

diagnostic blocks were included. Medial branch blocks were performed with local anesthetic, with or without steroids. The results showed significant differences in numeric pain scores and significant pain relief (50% or >) in 71% of the patient at 3 months and 6 months, 76% at 12 months, 71% at 24 months, and 69% at 36 months, compared to baseline measurements. Functional improvement was demonstrated at 1 year, 2 years, and 3 years from baseline. There was significant improvement with increase in employment among the patients eligible for employment from baseline to 1 year, 2 years, and 3 years in conjunction with improved psychological function.

#### *Cost Effectiveness*

The cost effectiveness of lumbar facet joint nerve blocks was evaluated by Manchikanti et al (119) with 1-year improvement of quality of life at \$3,461.

#### **Level of Evidence**

Evidence for therapeutic medial branch blocks in the lumbar, cervical, and thoracic spine is moderate for short- and long-term pain relief.

#### **Medial Branch Neurotomy**

Percutaneous neurotomy of medial branches is a procedure that offers pain relief by denervation of the nerves that innervate a painful joint. The denervation may be performed by radiofrequency thermoneurolysis utilizing thermal or pulsed mode, cryoneurolysis, or laser denervation.

For the current systematic review, a randomized trial by van Wijk and colleagues (123) that evaluated the effectiveness of radiofrequency neurotomy for relief of lumbar facet joint pain. The study was of high quality, based on AHRQ and Cochrane criteria, and assessed the effectiveness of radiofrequency neurolysis on lumbar facet pain in 81 patients randomized to active radiofrequency or sham lesioning. The combined outcome measure, based on the authors' multi-dimensional outcome tool (visual analogue scale back pain measurements, changes in daily physical activities, and analgesic use) showed no significant difference between radiofrequency denervation and sham. However, the global perceived effect, a secondary outcome, was better in the radiofrequency group. In selected patients, radiofrequency may have been better than sham intervention. Unfortunately, the study by van Wijk (123) failed to meet inclusion criteria and was subject to criticism on technical grounds. Bogduk (124) noted that the radiofrequency needle position

was improper. Needle tips were positioned perpendicular and too far lateral to the medial branch nerves to ensure denervation; this could increase the likelihood of treatment failure. It should also be noted that comparative, controlled diagnostic blocks were not used, which may have increased the false-positive rate of facet pain diagnosis, reducing the likelihood of noting a statistical effect with active treatment. Further, the relief at which they judged a patient to be positive for facet joint pain was only 50%.

Haspeslagh et al (125), in a pseudo-randomized controlled trial of cervical radiofrequency lesions as a treatment for cervicogenic headache, evaluated 30 patients according to Sjaastad diagnostic criteria, with 15 patients receiving a sequence of radiofrequency treatments with cervical facet joint denervation followed by cervical dorsal root ganglion lesions when necessary, and another 15 patients undergoing local injections with steroid and anesthetic at the greater occipital nerve, followed by transcutaneous electrical nerve stimulation when necessary. There were no statistically significant differences between the 2 treatment groups at any time point in the trial. They concluded that they did not find evidence that radiofrequency treatment of cervical facet joints and upper dorsal root ganglia is a better treatment than infiltration of the greater occipital nerve, followed by TENS for patients fulfilling the clinical criteria of cervicogenic headache. This study was problematic, not only in the diagnosis but also in the application of technique. The authors claim that they developed a sequence of various cervical radiofrequency neurotomies that proved successful in a prospective pilot trial with 15 chronic headache patients. Their diagnosis was not established by controlled diagnostic blocks; and the treatments targeted toward different structures: cervical facet joints and dorsal root ganglion compared to occipital nerves. Thus, this study was excluded from evidence synthesis.

Numerous prospective studies were identified. Barnsley (126) and Shin et al (127) evaluated the effectiveness of cervical medial branch radiofrequency, Birkenmaier et al (128) and Staender et al (129) evaluated the effectiveness of cryoneurolysis in managing lumbar facet syndrome, Mogalles et al (130) evaluated percutaneous laser denervation. There was also a retrospective evaluation of facet joint pain (131). The effectiveness of pulsed radiofrequency was also evaluated in 2 studies (132,133). The studies by Staender et al (129), Mogalles et al (130), Barnsley (126), Marti-

nez-Suarez et al (131), and Birkenmaier et al (128) met inclusion criteria.

However, the studies by van Wijk et al (123) and Shin et al (127) failed to meet inclusion criteria. Two studies evaluating pulsed radiofrequency (132,133) were also excluded.

In our previous systematic review, 2 randomized trials, one of the cervical spine (134) and 1 involving the lumbar spine (135) met inclusion criteria and are included in the present analysis. Four observational studies of cervical medial branch neurotomy (136-139) met criteria and are included from the previous review. Likewise, 6 observational studies of lumbar medial branch neurotomy (138-143) and 2 observational studies of thoracic medial branch neurotomy (138,144) met inclusion criteria in the previous systematic review and are included in the present analysis.

### Methodological Criteria

For the current systematic review, 8 randomized trials evaluating the efficacy of medial branch facet radiofrequency neurotomy were identified (123,125, 134,135,143-146), 2 with cervical medial branch neurotomy (125,134) and 6 with lumbar medial branch neurotomy (123,135,143-146). Among the randomized trials, only 2 met inclusion criteria. The study by Lord et al (134) evaluated the effectiveness of percutaneous radiofrequency neurotomy from cervical zygapophysial joint pain and the study by van Kleef et al (135) evaluated the effectiveness of radiofrequency lumbar facet denervation for chronic low back pain. The methodological scoring for both of the studies is illustrated in Table 5, along with study descriptions.

Other randomized trials were excluded as they failed to meet inclusion or methodological criteria. The study by LeClaire et al (144), which appeared to be a well-performed, double-blind, placebo-controlled trial, had several deficiencies. The study failed to define the study population using appropriate diagnostic criteria. This was considered a major error, because patients were evaluated with a single diagnostic block and pain relief was considered to be more than one day's relief during the 7-day period following the diagnostic block. Consequently, any results or conclusions also could be erroneous. A study by Gallagher et al (143) was not included because it used the invalidated Shealy technique, failed to describe appropriate diagnostic techniques and outcome analysis, and it was not clear whether interventions were performed with fluoroscopy. Three other studies were excluded from inclusion

and evidence synthesis; 1 study used intraarticular facet joint denervation (145), which is not medial branch neurotomy and is of unclear clinical relevance, and the other 2 studies (147, 148) described radiofrequency lesioning of dorsal root ganglia. The recent study by van Wijk (123) also failed to meet inclusion criteria and was excluded. This study failed to utilize comparative, controlled diagnostic blocks and reasonable pain relief criteria. In addition, needle tips were positioned perpendicular and 2 far lateral to the medial branch nerves to ensure denervation. A study by Haspeslagh et al (125) was excluded as they performed an inadequate procedure for cervical facet radiofrequency.

There were 15 observational studies (126-131, 136-142, 149, 150) identified that met inclusion criteria and were included in the review. Of these, 5 studies evaluated (Table 5) cervical facet radiofrequency thermoneurolysis (126, 136-139) and 11 studies evaluated (Table 6) low back pain (127-131, 138, 139, 140-142, 149); 2 of the studies (138, 150) included evaluations of thoracic facet joint pain (Table 7).

Birkenmaier et al (128) and Staender et al (129) utilized cryoneurolysis for medial branch neurotomy. Both studies were included in the analysis of evidence synthesis. Mogalles et al (130) utilized percutaneous laser denervation for medial branch neurotomy.

### Study Characteristics

Lord et al (134) evaluated percutaneous radiofrequency neurotomy for management of chronic cervical facet joint pain in a randomized, double-blind, placebo-controlled trial. They concluded that for patients with chronic cervical facet joint pain, confirmed by double-blinded, placebo-controlled local anesthetic blocks, percutaneous radiofrequency neurotomy with multiple lesions of target nerves can provide long-lasting relief.

van Kleef et al (135) randomized 31 patients to radiofrequency neurolysis or sham lesioning of lumbar facet medial branch nerves. At 3, 6, and 12 months, there were statistically more successes in the treatment group than the sham group. These results demonstrated that radiofrequency denervation of the lumbar facet joints can be effective for pain reduction in patients with lumbar facet joint pain.

The recent observational study by Barnsley (126) evaluated the results of radiofrequency for cervical facet joint pain as applied in usual clinical practice. All patients who underwent radiofrequency had the diagnosis of cervical facet joint pain made with com-

parative local anesthetic blocks. The primary outcome was duration of complete pain relief for all consecutive procedures performed over a two-year period. Forty-seven procedures were performed on 35 patients. Twelve patients underwent 2 procedures and 2 patients were lost to follow-up. Sixty percent of patients obtained complete pain relief for a duration in excess of 12 weeks. Overall, the mean duration of complete pain relief was 35 weeks.

A prospective study by Shin et al (127) evaluated the role of radiofrequency neurotomy of cervical medial branches for chronic cervicobrachialgia, radiating in typical facet joint patterns to the neck and shoulder. Twenty-eight patients with facet joint pain were identified with comparative local anesthetic blocks and subsequently underwent radiofrequency neurolysis. The primary outcome was pain relief at 1, 2, 3, 6, 9 and 12 months. Sixty-eight percent of patients had a successful outcome (> 50% pain relief) after 6 months of follow-up; 29% reported complete pain relief.

Birkenmaier et al (128) evaluated the benefit of cryodenervation (cryoneurolysis) for lumbar facet pain diagnosed with positive medial branch local anesthetic blocks. The study design was a prospective case series. Outcomes were low back pain improvement, improved activity, and overall satisfaction. Forty-six out of 50 patients completed the study. Outcomes were determined at 6 weeks and 3, 6, and 12 months. Overall, mean low back pain was significantly decreased from baseline at 3, 6, and 12 months. Significant improvement was seen in 72% of patients at 6 weeks, 70% at 3 months, and 57% at 12 months.

Staender et al (129) performed computerized tomography-guided cryorhizotomy in 76 patients with lumbar facet joint syndrome. In this prospective evaluation a diagnosis was established after 3 positive CT-guided medial branch nerve blocks. Outcome measurements, which included visual analog score, use of medication, ability to work, and physical condition were evaluated at 3 days, 3 months, and every 3 months thereafter, with a median follow-up period of 22.5 months, ranging from 6 to 43 months. They reported significant reductions in the VAS at 3 months and 6 months postoperatively. In 40% of patients, pain was reduced for 12 months or longer. Eighteen patients underwent a second, 7 a third, and 1 a fourth cryorhizotomy.

Mogalles et al (130) evaluated percutaneous laser denervation of the zygapophysial joints for lumbar facet pain. This prospective evaluation included per-

Table 5. Characteristics of results of studies of cervical medial branch neurotomy.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusions Short-term relief < 3 mos Long-term relief ≥ 3 mos.
Lord et al (134) Cervical zygapophysial joint nerve radiofrequency Randomized, placebo-controlled, double-blind trial AHRQ score: 9/10 Cochrane score: 9/10	24 patients with neck pain > 3 months' duration in cervical spine, confirmed by controlled blocks Control=12 Treatment=12.	RF group lesion 90 sec lesion at 80° C of medial branch; Control group received sham treatment with electrode insertion.	3, 6, and 12 month follow-up; 0 to 5 of 100 on VAS scale; Word count 3 or less on McGill Pain questionnaire.	Median time to return of pain in treatment group was 263 days; 8 days in control group; 10 patients underwent second procedures with varying results.	Positive short-term and long-term relief
Barnsley et al (126) Cervical zygapophysial joint nerve radiofrequency. Observational study AHRO score: 7/8	35 consecutive patients, all meeting diagnostic criteria for cervical zygapophysial joint pain.	Cervical zygapophysial joint nerve radiofrequency neurotomy.	Duration of complete relief of pain.	74% of patients treated obtained complete pain relief for a mean duration of 35 weeks (8.7 months).	Positive short-term and long-term relief
McDonald et al (137) Prospective, nonrandomized AHRQ score: 7/8	28 patients with cervical facet pain diagnosed by comparative local anesthetic blocks.	Cervical facet nerve radiofrequency; repeated when pain returned.	Pain relief and duration of benefit.	Complete pain relief obtained in 71% of patients after initial procedure. Median duration of relief was 219 days for all patients; 422 days for initial responders.	Positive short-term and long-term relief
Sapir and Gorup (136) Prospective nonrandomized AHRQ score: 7/8	46 patients with cervical whiplash symptoms completed the study. Litigant and non-litigant patients included.	The 2-phase diagnostic cervical medial branch blocks, followed by radiofrequency neurotomy.	VAS and self-report of improvement (SRI).	The difference between groups in the degree of symptomatology or response to treatment did not reach significance.	Positive short- and long-term relief
Shin et al (127) Radiofrequency neurotomy of lumbar medial branch nerves. Observational study AHRO score: 5/8	28 consecutive pts, all meeting diagnostic criteria for cervical facet joint pain.	Cervical medial branch radiofrequency neurotomy	Measured VAS scores at 1, 2, 3, 6, 9, and 12 months. Outcomes graded as successful (>75%); moderate (50-75%); and failure (<50%) improvement	69% of pts treated reported successful outcome after 6 months.	Positive for short-term and long-term relief
Tzaan and Tasker (138) Retrospective AHRQ score: 5/8	118 consecutive procedures in 90 patients diagnosed by local anesthetic facet nerve block.	Radiofrequency facet neurotomy at involved levels.	Pain relief.	41% of patients had >50% pain relief at an average follow-up of 5.6 months.	Negative short-term and long-term relief
Schaerer (139) Retrospective AHRQ score: 5/8	117 patients with a total of 50 cervical procedures.	Radiofrequency facet neurotomy at involved levels.	Pain, analgesics, and mood.	50% of 50 patients had >50% pain relief, with average follow-up of 13.7 months.	Negative short-term and long-term relief

Table 6. Characteristics of results of studies of lumbar medial branch neurotomy.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 3 mos Long-term relief ≥ 3 mos
van Kleef et al (135) Lumbar zygapophysial joint radiofrequency Randomized, placebo-controlled, double-blind trial AHRQ score: 9/10 Cochrane score: 7/10	31 pts (16 in Control, 15 in Treatment) with low back pain of at least 12 months' duration, confirmed by diagnostic controlled blocks.	RF group lesion 60 sec at 80°C of medial branch; Control group received sham treatment with electrode insertion.	2, 3, 6, and 12 months follow-up. Number of successes (> 2 pt reduction VAS, > 50% Global and Oswestry).	Statistically higher improvement in treatment than control at the indicated times (e.g.; 67% treat, 37% sham at 2 months).	Positive short-term and long-term relief
Dreyfuss et al (140) Prospective nonrandomized AHRQ score: 8/8	15 pts with chronic lumbar facet pain diagnosed by comparative local anesthetic blocks.	Lumbar radiofrequency; EMG of multifidus muscle used to determine accuracy of neurotomy.	Pain relief, functions, EMG at 6 weeks; pain relief and outcomes assessment at 3, 6, and 12 months.	60% of pts obtained at least 90% relief of pain at 12 months, and 87% at least 60% relief at 12 months.	Positive short-term and long-term relief
Mogalles et al (130) Prospective evaluation. AHRQ score: 6/8	15 pts were included with chronic low back pain diagnosed with facet pain by means of controlled, comparative local anesthetic blocks	Laser denervation of medial branches.	>50% pain relief.	8 of the 15 experienced complete relief and 6 experienced more than 50% pain relief.	Positive short-term and long-term relief
Vad et al (142) Prospective nonrandomized AHRQ score: 8/8	12 pts with sports-related low back pain diagnosed with medial branch blocks.	Radiofrequency neurotomy of the lumbar facets.	Pain relief and return to pretreatment level of function.	Mean duration of pain relief: 1.3 years. 83% of pts returned to pretreatment level of function.	Positive short-term and long-term relief
Birkenmaier et al (128) Cryodestruction of lumbar medial branch nerves Prospective clinical case series AHRQ score: 5/8	46 consecutive pts meeting criteria for refractory nonsciatic low back pain of at least 3 months with positive diagnostic medial branch blocks.	Cryoneurolysis of lumbar medial branch nerves.	Timing: 6 weeks, 3, 6, and 12 months. Outcome measures: VAS to ADLs measured on four-step simplified McNab.	Statistically significant improvement in mean low back pain of (≥50%) at all points; success or partial success achieved in 72% of pts at 6 wks; 70% at 3 mos, and 57% at 12 mos.	Positive short-term and long-term relief
Staender et al (129) Prospective evaluation AHRQ score: 5/8	76 patients with chronic low back pain with a diagnosis of lumbar facet joint syndrome. The diagnosis was established after 3 positive CT-guided medial branch nerve blocks.	Kryorhizotomy of lumbar medial branch nerves.	Outcome measures: VAS, medication usage, ability to work, physical conditions. Timing: 3 days, 3 mos, and every 3 mos thereafter, with a median follow-up period of 22.5 mos.	Significant reduction in the VAS at 3 mos and 6 mos were observed postoperatively. In 40% of patients, pain was reduced for 12 mos or longer. 18 patients underwent a second, 7 patients underwent a third, and 1 patient underwent a fourth procedure.	Positive short-term and long-term relief

Table 6 Continued. *Characteristics of results of studies of lumbar medial branch neurotomy*

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief < 3 mos Long-term relief ≥ 3 mos
Martinez-Suarez et al (131) Retrospective evaluation AHRQ score: 4/8	252 pts with diagnosis of lumbar facet joint pain were included.	Radiofrequency medial branch neurotomy.	Pain relief.	Effectiveness in 74.7% of cases.	Positive short-term and long-term relief
North et al (149) Retrospective AHRQ score: 6/8	82 pts with lumbar pain of facet origin diagnosed by facet nerve blocks.	Radiofrequency neurotomy of the lumbar facets for 42 pts.	Pain relief and function.	45% of pts with radiofrequency reported >50% pain relief at 2 yrs.	Negative short-term and long-term relief
Tzaan and Tasker (138) Retrospective AHRQ score: 5/8	90 pts diagnosed by local anesthetic blocks.	Radiofrequency facet neurotomy at involved levels.	Pain relief.	41% of pts had >50% relief at an average follow-up of 5.6 months.	Negative short-term and long-term relief
Schaerer (139) Retrospective AHRQ score: 5/8	117 pts 71 lumbar procedures	Radiofrequency facet neurotomy at involved levels.	Pain, analgesics, and mood.	35% of 71 lumbar RF had >50% pain relief, with average follow-up of 13.7 mos.	Negative short-term and long-term relief
Schofferman and Kine (141) Retrospective AHRQ Score: 5/8	20 pts underwent repeat radiofrequency neurotomy. Medial branch blocks used for initial diagnosis.	Radiofrequency neurotomy of the lumbar facets; repeated as indicated clinically.	Pain relief.	Mean duration of relief of initial RF was 10.5 mos. Second treatment effective in 85%; mean duration of relief of 11.6 mos.	Positive short-term and long-term relief

cutaneous laser denervation in 15 patients in whom facet joint pain was confirmed by 2 diagnostic blocks. Of the 15 patients undergoing laser denervation, 8 experienced complete relief and 6 experienced more than 50% pain relief. They concluded that laser denervation was an effective treatment. This appears to be the first published report on laser denervation in a prospective study. Though selection criteria were appropriate, there were no outcome parameters and the results have not been substantiated in a randomized, double-blind trial.

Among the previously reviewed nonrandomized or observational studies, Dreyfuss et al (140) described lumbar facet joint radiofrequency neurotomy and found 60% improvement in 80% of patients at 1 year. McDonald et al (137) determined the long-term efficacy of percutaneous radiofrequency medial branch neurotomy for the treatment of chronic neck pain in 28 patients diagnosed as having cervical zygapophysial joint pain, on the basis of controlled diagnostic

blocks. They reported a median duration of relief after the first procedure of 219 days when failures were included, and 422 days when only the successes were considered. In addition, radiofrequency neurotomy of the cervical zygapophysial joints significantly reduced headache severity in 80% of patients, both at short-term and long-term follow-up.

Among the retrospective evaluations, Martinez-Suarez et al (131) evaluated 252 patients with a diagnosis of lumbar facet joint pain with radiofrequency neurotomy of medial branches. They reported effectiveness in 74.7% of cases. Tzaan and Tasker (138) evaluated 118 consecutive percutaneous radiofrequency facet rhizotomies performed on 90 patients for cervical, thoracic, and lumbar pain. They reported that with the first procedure, greater than 50% subjective reduction of pain was present in 41% of patients; this was considered a negative outcome. They included cervical, thoracic, and lumbosacral facets and noted no significant difference between unilateral or



Table 7. Characteristics of results of studies of thoracic medial branch neurotomy.

Study/Methods	Participants	Intervention(s)	Outcome(s)	Result(s)	Conclusion(s) Short-term relief <3 mos Long-term relief ≥3 mos
Tzaan and Tasker (138) Retrospective AHRQ score: 5/8	90 pts diagnosed by local anesthetic blocks.	Radiofrequency facet neurotomy at involved levels, including thoracic.	Pain relief.	41% of pts had >50% relief at an average follow-up of 5.6 months.	Negative short-term and long-term relief
Stolker et al (150) Retrospective AHRQ score: 5/8	40 pts with chronic thoracic facet pain diagnosed with medial branch block.	Thoracic radiofrequency facet neurotomy.	Pain relief.	At an average follow-up of 31 months, 83% had >50% relief.	Positive short-term and long-term relief

bilateral involvement. On the other hand, the retrospective study by Stolker et al (150) was positive for thoracic facets.

North et al (149) evaluated radiofrequency lumbar facet denervation with long-term outcome assessment by a disinterested third party interview. Forty-five percent of patients undergoing denervation reported at least 50% relief of pain at long-term follow-up. Schaeffer (139) evaluated the value of radiofrequency facet rhizotomy in the treatment of patients with chronic neck and low back pain problems in 90 consecutive patients, undergoing 117 procedures. They reported that overall results were good to excellent in 50% of the patients in cervical spine and 35% in lumbar spine with an average follow-up time of 13.7 months. Schofferman and Kine (141) demonstrated that radiofrequency neurolysis can be repeated when pain returns, re-establishing long-term pain relief in 85% of patients.

Criticisms faced by these trials include the overall relatively small number of patients. The total number of patients combined for cervical and lumbar regions in the randomized trials was 27 in the treatment groups, compared to 28 in the control groups. Consequently, the number of patients undergoing a cervical or lumbar intervention was small. An additional criticism for van Kleef's et al's (135) study is that they included patients after a single diagnostic block, which may increase the false-positive rate. Prospective studies also had a small total number of patients.

#### Cost Effectiveness

No studies were performed evaluating cost effectiveness of medial branch neurotomy.

#### Level of Evidence

No new randomized trial was included in the present analysis, because of technical difficulties with the one identified randomized study. However, several new observational studies were included in the present analysis, including a report on cryoneurolysis of lumbar medial branches. The evidence for neurotomy (radiofrequency and cryoneurolysis) is moderate or Level III for long-term relief of cervical and lumbar facet joint pain. This is a change from our previous systematic review (1), where evidence was moderate to strong for short- and long-term relief. However, we would like to emphasize that cervical medial branch radiofrequency performed as advocated by Bogduk (151), and as reported in a randomized study by Lord et al (134) and prospective evaluations by McDonald et al (137) and Barnsley (126), involves producing multiple lesions at each medial branch location in the cervical spine, with significantly longer duration of operative time. This technique is not routinely practiced in the United States. But, with this technique, the evidence for cervical medial branch radiofrequency neurotomy is considered strong for short-term and long-term relief. For all other techniques, the evidence is strong for short-term and moderate for long-term relief in managing lumbar and cervical facet joint pain with radiofrequency thermoneurolysis. The evidence for thoracic medial branch radiofrequency is indeterminate.

The evidence is indeterminate for pulsed radiofrequency and laser medial branch neurotomy.

### Safety and Complications

Our search strategy (complications/facet injections/denervation/radiofrequency) yielded 6 new articles. Several additional references were identified during searches for facet interventions. Septic joints and transient tetraplegia have been reported after intraarticular facet injections (152,153). Following radiofrequency denervation, post-procedural MRI findings can demonstrate contrast enhancement typical of that seen with a paraspinal abscess, even without apparent infection (154). The authors suggested that pain after radiofrequency may be due to a noninfectious postinflammatory process and may not warrant antibiotic treatment unless indicated on clinical grounds (154).

The risks associated with needle injections may be higher in the cervical spine, particularly with intraarticular facet joint injections and perhaps medial branch blocks. Although quantitative data are lacking, a recent anatomic study by Huntoon (155) demonstrated that the deep cervical artery lies adjacent to the upper cervical facets and may anastomose with the circulation of the cervical spinal cord in about 10% of individuals. Cervical arteries may be vulnerable during soft tissue injections adjacent to the cervical spine. The risk of such a complication is supported by a recent case report by Heckmann et al (153), who noted transient tetraplegia after a cervical facet joint injection for chronic neck pain done without imaging. Immediately following a presumed facet injection at the C6 level guided by anatomical landmarks, the patient developed tetraplegia that lasted for about 30 minutes. Proprioception remained intact throughout. The patient made a rapid and complete recovery. The authors surmised that an inadvertent injection of local anesthetic into a radicular artery feeding the anterior spinal artery temporally compromised the cervical spinal cord. Although the precise mechanism is speculative in this case given the lack of fluoroscopic imaging, cervical facet injections may be associated with major complications.

The most common and worrisome complications of facet joint interventions were related to needle placement and drug administration. Potential complications include dural puncture, spinal cord trauma, infection, intraarterial or intravenous injection, spinal anesthesia, chemical meningitis, neural trauma, pneumothorax, radiation exposure, facet capsule rupture, hematoma formation, and steroid side effects (156-172).

Potential side effects with radiofrequency denervation include painful cutaneous dysesthesias, in-

creased pain due to neuritis or neurogenic inflammation, anesthesia dolorosa, cutaneous hyperesthesia, pneumothorax, and deafferentation pain. Unintentional damage to a spinal nerve during medial branch radiofrequency, causing a motor deficit, is also a possible complication of a neurolytic procedure.

A retrospective chart review of patients undergoing radiofrequency neurotomy for lumbar facet joint pain over a 5-year period provided complication rates associated with the procedure (171). During 116 separate denervation procedures, 6 minor complications were noted, including 3 cases of localized pain lasting > 2 weeks and 3 cases of neuritic pain lasting < 2 weeks. In that study, there were no cases of infection or new sensory or motor deficits. The overall rate of complications, which were minor, was 1%.

### DISCUSSION

This systematic review provides an update of the evidence for the effectiveness of facet interventions for the management of chronic facet joint spinal pain. Only 2 new studies were included in the evidence synthesis for intraarticular facet joint injections. Although the study by Gorbach et al (101) was technically satisfactory based on AHRQ criteria, the diagnosis of facet pain was made on clinical grounds and not on the basis of diagnostic blocks. Although the results were positive for the value of intraarticular facet injections for short-term relief, the lack of diagnostic blocks as a requirement for patient inclusion was deemed to be a significant criticism of the study. Therefore, the study was not included in the current evidence synthesis.

The study by Fuchs et al (100) evaluated the efficacy and safety of intraarticular sodium hyaluronate (SH) as compared with intraarticular triamcinolone acetonide in the treatment of chronic nonradicular lumbar pain. They included 60 patients in a randomized, controlled, blind-observer clinical study and randomly assigned patients to receive 10 mg of SH or 10 mg TA per facet joint. The facet joints on both sides at levels L3/4, L4/5, and L5/S1 were treated once per week under computed tomographic guidance, for a total of 6 injections. The study demonstrated significant pain relief, improved function, and quality of life with both treatments; intraarticular hyaluronate was equivalent to intraarticular steroid, for a period of up to 6 months. The drawbacks of this study include lack of diagnosis of facet joint pain by controlled local anesthetic blocks, which may have increased the probability of inclusion of patients without facet joint pain.

A second report, a prospective observational study by Kim et al (103) was included in the evidence synthesis. Patients with cervical facet joint pain were treated with therapeutic facet joint injections with lidocaine and triamcinolone under fluoroscopy. Patients were classified into a herniated nucleus pulposus group, myofascial pain syndrome group, and whiplash-associated disorders group. The symptom-free duration after blockade lasted longer in the herniated nucleus pulposus group (11.3 ± 1.7 months). The authors suggested that perpetuating factors associated with myofascial and whiplash pain may not respond as well as pain associated with disc degeneration. The results do suggest that intraarticular cervical facet injections may be helpful for facet pain associated with disc herniation.

In the previous systematic review regarding intraarticular facet joint injections, only the randomized trial of lumbar spine pain by Carette et al (104) was considered positive, with a 42% success rate. In contrast, a randomized trial of cervical spine pain following whiplash injury by Barnsley et al (108) was negative. Among the nonrandomized trials, positive results were noted for short-term relief in 5 of the 6 studies. However, long-term relief was noted in only 4 of the 6 studies.

The evidence for the effectiveness of intraarticular facet injections is moderate for short- and long-term relief of lumbar facet pain. The only randomized trial of cervical spine facet joint injections was negative, although there are 2 positive observational studies available (103,115). Based on the previous analysis and with 2 new studies, the evidence for the effectiveness of cervical intraarticular facet joint injections is limited for short- and long-term relief.

Regarding medial branch blocks for management of facet joint pain, 3 new studies evaluated the effectiveness of medial branch blocks for chronic facet pain. Manchikanti et al (116) evaluated pain relief with cervical medial branch blocks in a randomized, double-blind, controlled trial using four types of injections. Significant pain relief (> 50%) and improvement in functional status were observed at 3, 6, and 12 months. The average number of treatments for 1 year was approximately 3 to 4 injections, with no difference between treatment groups. Duration of relief was approximately 14 weeks per treatment. Although there was no placebo control group in the study, the results demonstrated that medial branch nerve blocks, with or without steroid, could provide predictable

pain relief. Inclusion of betamethasone in the injectate did not appear to provide additional benefit. This study provides further evidence that cervical facet joint medial branch blocks may be considered therapeutic in nature and with repeated injections may be a means of providing durable relief of facet pain without neurolysis.

In the second new study, Manchikanti et al (117) evaluated 60 patients in a randomized, double-blind, controlled trial. Patients with lumbar facet pain diagnosed with comparative local anesthetic medial branch blocks were randomized to receive therapeutic local anesthetic medial branch blocks of lumbar facets, with or without steroid (betamethasone). Statistically significant pain relief and functional status improvement were observed at 3 months, 6 months, and 12 months, compared to baseline measurements. The average number of treatments per patient for 1 year was approximately 3.5 injections, with no significant differences noted between treatment groups. Duration of average pain relief with each procedure session was about 3.5 months. This small, randomized study provides additional evidence that medial branch blocks may be considered therapeutic for patients with chronic low back pain of facet origin.

The third new study (118) examined the therapeutic benefit of thoracic medial branch blocks in a prospective outcome study. In 55 consecutive patients with thoracic facet pain confirmed by comparative diagnostic facet nerve blocks, more than two-thirds of patients obtained significant pain relief (> 50%) with bupivacaine and methylprednisolone at 3, 6, 12, 24, and 36 months, compared to baseline measurements. Patients received approximately 3 to 4 blocks per year with an average duration of relief per treatment of about 4 months. As with the cervical facet nerve block report, this study provides evidence that repeated medial branch blocks may provide durable relief of spinal pain of thoracic facet joint origin.

Based on the 3 new studies and the previously reviewed reports for medial branch facet nerve blocks, evidence for relief of chronic cervical, thoracic, and lumbar facet pain is considered moderate for short- and long-term pain relief. Based on best evidence, long-term relief of facet joint pain with medial branch blocks may require local anesthetic injections at intervals of approximately 3 to 4 months, with or without steroid.

Regarding radiofrequency neurotomy for lumbar facet pain, a randomized trial by van Wijk and colleagues (123) was identified for the current sys-

tematic review. The study was of high quality, based on AHRQ and Cochrane criteria; however the study was subject to criticism on technical grounds. Bogduk (124) noted that the radiofrequency needle position was improper, with needle active tips located too far lateral to the medial branch nerves to ensure denervation. This could have increased the likelihood of treatment failure. It should also be noted that single diagnostic blocks were used with a criterion of 50% pain relief, rather than comparative controlled diagnostic blocks with 75% or 80% pain relief, which may have increased the false-positive rate. This may have reduced the likelihood of noting a statistical effect with active treatment. Based on these limitations, the study was excluded from further analysis for the current review.

A prospective outcome study of cervical facet radiofrequency by Barnsley (126); a prospective study by Shin et al (127) of pain relief with lumbar facet radiofrequency; a retrospective study of lumbar pain by Martinez-Suarez et al (131); and 2 studies by Birkenmaier et al (128) and Staender et al (129) of cryodenervation of lumbar facets met inclusion criteria and were included in the present analysis. These studies were positive for short- and long-term relief of facet pain.

From our previous systematic review, 2 randomized trials, 1 of the cervical spine (134) and 1 involving the lumbar spine (135), met inclusion criteria and are included in the present analysis. Both of these studies, which involved small numbers of patients, were positive for short- and long-term pain relief.

The 4 observational studies of cervical medial branch neurotomy (136-139) from the previous systematic review are included in the current analysis, 2 of which were positive for short- and long-term pain relief. The 6 observational studies of lumbar medial branch neurotomy (138,139,140-143) from the previous review met criteria for inclusion in the current analysis. Of these, 3 studies were positive for short- and long-term pain relief. Two observational studies

of thoracic medial branch neurotomy (138, 150) met inclusion criteria in the previous systematic review and are included in the current analysis. Of these 2 studies, 1 was positive for short- and long-term pain relief (150).

Regarding radiofrequency neurolysis for chronic facet pain, no new randomized trial was included in evidence synthesis, because of technical limitations of the 1 new randomized study (123). However, several new observational studies met inclusion criteria and were incorporated into evidence synthesis, including a report on cryoneurolysis of lumbar medial branches.

Based on current information, the evidence for neurotomy (radiofrequency and cryoneurolysis) is moderate for short- and long-term relief of lumbar and cervical facet joint pain and indeterminate for thoracic facet pain. If the denervation protocol used by Lord et al (134), McDonald et al (137) and Barnsley (126) is followed, which is extensive and involves producing multiple lesions of each facet nerve, the evidence is strong for short- and long-term relief of pain with cervical medial branch neurotomy.

## **CONCLUSION**

Based on a systematic review of the included studies described herein, for cervical intraarticular facet joint injections, the evidence is limited for short- and long-term pain relief. For lumbar intraarticular facet joint injections, there is moderate evidence for short- and long-term pain relief.

For cervical, thoracic and lumbar medial branch nerve blocks, the evidence is moderate for short- and long-term pain relief.

The evidence for neurotomy (radiofrequency and cryodenervation) of cervical and lumbar medial branch nerves is moderate for short- and long-term pain relief. The evidence is strong for cervical medial branch neurotomy if the procedure is performed with multiple lesions, as described by Lord et al (134), McDonald et al (137), and Barnsley (126). The evidence for thoracic medial branch neurotomy is indeterminate.

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