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A Systematic Review

Diagnostic Utility of Facet (Zygapophysial) Joint Injections in Chronic Spinal Pain: A Systematic Review of Evidence

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Background: Chronic refractory spinal pain poses a peculiar diagnostic challenge because of multiple putative pain sources, overlapping clinical features, and nonspecific radiologic findings. Diagnostic injection techniques are employed to isolate the source(s) of pain. Facet or zygapophysial joint pain is an example of spinal pain diagnosed by local anesthetic injections of the facet joint or its nerve supply. Diagnostic facet joint injections are expected to meet the cardinal features of a diagnostic test (i.e., accuracy, safety and reproducibility). Accuracy must be compared with a "gold" or criterion standard that can confirm presence or absence of a disease. There is, however, no available gold standard, such as biopsy, to measure presence or absence of pain. Hence, there is a degree of uncertainty concerning the accuracy of diagnostic facet joint injections.

Objectives: To evaluate accuracy, safety and reproducibility of facet or zygapophysial joint injections in diagnosing chronic spinal pain of facet joint origin.

Study Design: A systematic review of the literature for clinical studies on efficacy and utility of facet joint/nerve injections in diagnosing spinal pain from facet joints.

Methods: Relevant literature on diagnostic facet injections was identified through database searches. Excluded were abstracts, reviews, book chapters, case reports and studies based on single blocks or blocks without radiologic control. Prospective studies with placebo control, or controlled comparative local anesthetic blocks, were given priority over retrospective studies. Each study was graded using AHRQ and QUADAS criteria. The level of evidence was classified as conclusive, strong, moderate, limited, or inconclusive.

Results: Available literature pointed to strong evidence for controlled comparative local anesthetic facet joint medial branch blocks in the diagnosis of neck and low back pain. There was moderate evidence in the diagnosis of pain arising from thoracic facet joints.

Conclusion: The evidence obtained from literature review suggests that controlled comparative local anesthetic blocks of facet joint nerves (medial branch or dorsal ramus) are reproducible, reasonably accurate, and safe. The sensitivity, specificity, false-positive rates, and predictive values of these diagnostic tests for neck and low back pain have been validated and reproduced in multiple studies.

Keywords: Chronic spinal pain, neck pain, low back pain, cervical facet joint, thoracic facet joint, lumbar facet joint, zygapophysial joint, medial branch block, intraarticular injection

Spinal pain is a major cause of chronic pain and disability (1, 2). In patients with chronic spinal pain, the prevalence of pain by spinal region has been reported as 44% for cervical, 56% for lumbar, and 15% for the thoracic spine (3, 4). Despite the overall high prevalence of chronic spinal pain, on the basis of the clinical examination, a specific etiology can be established with certainty in only 15% of patients (5-9).

A practical approach to the treatment of chronic low back pain requires a specific anatomical diagnosis (9). For an anatomic structure to be deemed a potential cause of back pain it must fulfill four criteria:

1) the structure must have a nerve supply;
2) it should be capable of causing pain similar to that seen clinically in normal volunteers;
3) it must be susceptible to painful diseases or injuries; and
4) using diagnostic techniques of known reliability and validity, the structure must be a demonstrated as a source of pain in patients (10).

Facet joints are a well-recognized source of pain in subjects with persistent spinal pain (10-56). However, there are no specific markers of facet joint pain. Conventional clinical and radiologic techniques are unreliable in diagnosing facet or zygapophysial joint pain (2, 9, 10, 27-29, 32-34, 36, 42, 43, 45-70). Controlled local anesthetic blocks of the facet joint or its nerve supply are employed to diagnose facet joint pain. Single uncontrolled facet blocks are compromised by an unacceptably high false-positive rate and low predictive value (27-31, 33-35, 37-41, 44, 71-80). Placebo-controlled techniques, considered as the gold standard, have limited clinical utility due to ethical and cost implications. The use of controlled comparative blocks with short and long acting local anesthetics is an acceptable alternative strategy (27-31). The validity and accuracy of these precision diagnostic techniques, however, has been questioned (72-74, 80).

It is reported that precision diagnostic needle blockade of a structure with a nerve supply, and ability to generate pain, has several advantages over other available diagnostic techniques. It permits testing

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of the hypothesis that a target structure is the source of a patient's pain (27, 45). When combined with fluoroscopic guidance, it selectively and accurately accesses targeted spinal structure(s) (e.g., disc, facet joint, or spinal nerve) that are otherwise inaccessible to palpation. Injection of radiopaque contrast dye confirms that the target structure, and only the target structure, has been reached by the needle or by anything injected through it (45). The physiologic response to a block (presence or absence of pain relief) is used to determine whether or not the target structure is painful. Noninvasive imaging studies lack this capability. Finally, by using controlled blocks, the validity of the test can be critically evaluated in each and every patient.

The accuracy of a diagnostic test is determined by assessing specificity and sensitivity. Specificity is a relative measure of the prevalence of false-positives, whereas sensitivity is the relative prevalence of false-negative results. There is no test in clinical medicine that has an ideal 100% sensitivity and specificity. Consequently, there is a degree of uncertainty regarding the accuracy of each and every diagnostic test as applied to an individual clinical case.

Hildebrandt (73), in an extensive review on the relevance of diagnostic zygapophysial joint blocks, concluded that the diagnostic use of neural blockade rests on three premises:

1) The pathology causing pain is located in an exact peripheral location, and impulses from this site travel via a unique and consistent neural route;
2) Injection of local anesthetic totally abolishes the sensory function of intended nerves and does not affect other nerves; and
3) Relief of pain after local anesthetic block is attributable solely to the block of the target afferent neural pathway.

According to Saal (74), tests used for diagnosing the source of chronic low back pain require accurate determination of the abolition or reproduction of the patient's pain symptoms. He compared precision diagnostic injections to physical examination tests that, unlike most laboratory tests in clinical medicine, do not have an absolute gold standard in the form of a tissue diagnosis to determine their true accuracy. He recommended that rather than concluding these tests as useless or invalid, multiple facts should be considered together with the inaccuracies that are present in all diagnostic tests in medicine.

Bogduk and McGuirk (9, 45, 81, 82) described in detail the accuracy and value of precision diagnostic blocks and proposed an algorithmic approach to diagnosis of chronic low back pain. Manchikanti et al (2), in an evidence-based evaluation of diagnostic interventional techniques provided strong affirmation of the validity, specificity, and sensitivity of facet joint nerve blocks in the diagnosis of spinal pain of facet joint origin. Boswell et al (28) in a systematic review reported the accuracy of precision diagnostic blocks in the diagnosis of chronic spinal pain of facet joint origin. They reported the diagnostic accuracy of controlled local anesthetic facet joint blocks as high.

In contrast, Nachemson and Vingård (83), in assessment of patients with neck and back pain, concluded that various studies employed outside imaging have rarely demonstrated clinical utility. Ramsey et al (84) found that diagnostic and treatment devices that lacked scientific rigor included facet blocks, discography and diagnostic nerve root infiltration, along with electromyogram, stress radiographs and flexion and extension x-rays, bone scintigraphy, thermography, diagnostic ultrasound, and temporary external fixation. North et al (71) reported a limited role for uncontrolled local anesthetic blocks in the diagnostic evaluation of sciatica and referred pain syndromes in general. They also noted that negative blocks are a pattern of responses that may have some predictive value, but isolated, uncontrolled positive blocks are non-specific.

It is suggested that these reported disadvantages can be overcome by applying International Association for the Study of Pain (IASP) criteria (85) and using controlled diagnostic blocks. Face validity of facet joint blocks has been demonstrated (86-88). Construct validity is maintained by the use of comparative local anesthetic blocks, on two separate occasions, when the same joint is anesthetized using two local anesthetics with different duration of action (30-44, 75-79, 89-91).

This systematic review was undertaken to determine the accuracy of facet joint blocks in diagnosing chronic spinal pain.

Methods

Search Strategy

A computerized database search was performed of MEDLINE (January 1966-November 2004), OVID Current Contents, CINAHL, OVID PreMedline, Cochrane Database of Systematic Reviews, PUBMED, BioMedCentral, and EMBASE. The search included manual searches of bibliographies of systematic and narrative reviews and cross references to the reviews. Keywords used in the search were: Facet joint/zygapophysial joints as causes of neck/back pain; facet joint/diagnostic injections; diagnostic joint and nerve injections.

Inclusion Criteria

Type of studies

All prospective and retrospective studies on diagnostic facet joint/nerve injection were selected for review. In grading the evidence, randomized, double-blinded, and prospective studies were given priority over retrospective studies.

Types of participants

Subjects experiencing more than three months of chronic spinal pain of sufficiently severe intensity to warrant further investigations or justify referral to pain/spine specialist, and who had failed adequate trial of conservative management with medications, physical therapy, psychological interventions.

Types of Interventions

Double block comparative controlled or placebo-controlled studies.

Types of Outcomes

The criterion standard for diagnosis of facet joint pain was >50% pain relief and the ability to perform previously painful maneuvers following joint/medial branch blocks.

Exclusion criteria

Type of studies

Studies not meeting inclusion/exclusion criteria, appropriate outcomes and statistical analysis; articles reporting animal, cadaver, autopsy studies; biomechanical and imaging studies; case reports, book chapters, reviews, guidelines, and expert opinions.

Types of participants

Subjects with pain duration of <3 months and asymptomatic / normal volunteers.

Types of Interventions:

1) Single block studies (i.e., facet joint or nerve injections without comparative control or placebo control).
2) Studies without radiologic guidance.
3) Studies describing an injection technique.
4) Pain mapping studies.
5) Studies reporting therapeutic facet joint procedures (i.e., medial branch blocks, radiofrequency neurotomy or intraarticular steroid injections).

Method of Review

Abstracts obtained from computerized database searches were initially screened for exclusion criteria. Relevant articles were evaluated according to Agency for Healthcare Research and Quality (AHRQ) criteria (92) (Appendix A and B) and QUADAS criteria (Appendix C). Articles were included if they fulfilled at least three of five AHRQ criteria and/or seven of 14 QUADAS criteria for individual articles.

The following data was extracted and tabulated: principal author, study design, number of subjects at enrollment and (where available) final analysis, inclusion-exclusion criteria, subject characteristics, interventions, outcome measures, follow up interval, statistical analysis and results. Finally three physician reviewers reviewed selected studies for methodologic quality and grading of evidence.

Results

Database search yielded 150 relevant articles on facet/zygapophysial joints. A database article log was created, each article was reviewed for inclusion or exclusion criteria, and reasons for exclusion documented in the article log. Thirty-seven studies (30-44, 51, 56, 67-70, 75-79, 94-96, 98-105) were selected for review and abstracting. Of these studies, three were clinical outcome studies (94-96), one study evaluated combined disc and facet joint pain (101), one was a subgroup analysis of subjects from two previous studies (102), and one was a retrospective evaluation (105). Two studies evaluated the effect of conscious sedation as a confounding factor (99,100), and one study (98) evaluated the influence of psychological factors on the diagnostic ability of controlled local anesthetic blocks.

Study Design

There were 10 randomized trials (30, 31, 42, 43, 51, 68, 69, 75, 99, 100) and 17 prospective studies (32-41, 44, 76-78, 98, 103, 104). Seven studies were randomized, double blind (30, 42, 68, 69, 75, 99, 100) and four were placebo-controlled, double blind studies (31, 43, 99, 100). An independent observer randomly examined every fifth patient in two prospective studies (32, 51). Accurate needle placement was confirmed prior to local anesthetic injection by independent observers in four studies (30, 31, 43, 75), and in one study an independent observer graded pain relief (104). Confounding factors were evaluated in three controlled studies (98-100) and long-term validity of lumbar facet diagnosis was reported in one study (97). Five studies evaluated validity of diagnostic blocks (30, 31, 86-88). Seventeen studies (32-44, 76-78, 105) reported prevalence of facet joint pain and 14 studies (33-35, 37-41, 44, 75-79) reported false-positive rates of single diagnostic facet blocks.

Subject Enrollment and Dropouts

There were less than 100 subjects enrolled in 13 studies (30, 31, 36, 41-43, 68, 75, 97, 101, 103-105), 100-200 subjects in 14 studies (32-34, 37, 39, 42, 51, 69, 76-78, 98-100), and >500 subjects in one study (40). Seven studies reported dropouts (36, 42, 43, 69, 97, 101, 105), 13 studies reported no dropouts (33-35, 37-41, 44, 75, 98-100), and other studies did not mention dropouts.

Setting and Location

Seventeen studies were conducted in private practice settings: interventional pain management, spine, radiology or physical medicine and rehabilitation practice, and three studies were reported from a university/tertiary referral center in Australia. Other specialists or practitioners referred subjects for further workup and/or treatments to these practices or centers.

Spine Region Studied

Ten studies assessed subjects for cervical facet pain (30, 31, 39, 40, 42-44, 75, 99, 105), two studies reported prevalence of pain from thoracic facets (40, 41), and 17 studies evaluated lumbar facets in subjects with low back pain (32-40, 51, 76-79, 98, 100, 104). One study (102) performed subgroup analysis, and one (79) was a statistical analysis of subjects from a previous study. Three studies (38-40) reported on prevalence of pain in more than one spine region.

Inclusion Criteria

Pain duration of more than three months was a consistent inclusion criterion across all studies. Other criteria varied by study. There were multiple studies that enrolled subjects with pain onset following injury at work, motor vehicle accident (MVA), or other injury. Multiple studies included subjects with prior lumbar spine surgery, and some studies included psychological assessments. Twelve studies analyzed clinical features for predicting response to cervical or lumbar facet joint injections (32-36, 43, 51, 67-70, 75). Also reported were the influences of age (76), smoking (62), obesity (78), prior surgery (77), psychological comorbidities (98), and sedation (99, 100) on the prevalence of facet joint pain and diagnostic validity of facet joint injections.

Interventions

Except for three studies, all of the studies reviewed utilized double diagnostic blocks with lidocaine and bupivacaine to diagnose facet joint pain. There were two studies that employed placebo-controlled triple blocks (31, 43), and one study randomized subjects to intraarticular normal saline or lignocaine injections (68). The interval between first and second (and third) block was usually two or more weeks except in two studies where the interval was one week (32, 43). One study did not specify this interval (69). Each study described the method or algorithm, employed to determine the levels and/or sequence of injections. Two studies reported the number of injections performed to identify a positive joint (75, 105). In four studies, other diagnostic procedures were performed on the same day as the initial blocks (32, 51, 69, 101). The physician performing the procedure was masked in four studies (31, 43, 68, 75). Two studies evaluated each block for unsuccessful technique and repeated unsuccessful blocks on another day (30, 75).

Small volumes of local anesthetics within the recommended range were employed for intraarticular or medial branch blocks. Most studies used lidocaine for the first set of injections and reserved bupivacaine for the second injection in lidocaine

positive joints. There were five studies that injected lidocaine and bupivacaine in random sequence (30, 31, 43, 69, 75). In several studies steroids and Sarapin were added as adjuvant(s). Use of mild intravenous sedation with midazolam and fentanyl was reported in some studies.

Measurements/Outcomes

Analgesic response to local anesthetic injection was the primary outcome measure. Pain scores were recorded on visual analog scale (VAS) or numeric pain rating scale (NPS) before the procedure and after the procedure. All but one article (103) described the degree of pain relief either as a percentage or graded from worse to complete pain relief. The criterion for second (confirmatory) block varied from >50% pain relief to complete abolition of pain. The criterion used for diagnosis of facet joint pain was significant pain relief (50% to complete relief) for the duration of anesthetic used (>45 minutes to >2 hours with Lidocaine and >2-3 hours with Bupivacaine), and pain relief from bupivacaine lasting beyond that obtained from lidocaine, and/or ability to perform prior painful movements.

There was one study that determined diagnostic significance of pain provocation response and graded the evoked pain response from unfamiliar to exact pain (104). Four studies (34, 51, 69, 70) determined predictive value of previously reported clinical criteria for facet joint pain.

Statistical Analysis

Commonly used statistical tests consisted of Chi-square test, frequency and contingency tables, 95% confidence interval analysis for prevalence, sensitivity, specificity, predictive values and likelihood ratios. Two studies provided tables for determining positive and negative predictive values for single blocks (75, 79) and controlled blocks (75) at varying prevalence or pretest possibilities. Statistical significance was determined by using P values of <0.05. Some studies employed additional tests such as Fisher's exact test, ANOVA, Student's T test, Regression analysis, Kappa and sample size calculation.

Validity

Medial branch blocks have been shown to maintain face validity. Local anesthetic injected accurately onto the correct target points selectively infiltrates the target nerve, and does not anesthetize any adjacent structures that might be an alternative source of pain to the zygapophysial joint (86, 87). In addition, medial branch blocks have been shown to protect normal volunteers from pain provoked experimentally from the anesthetized joint (88).

Medial branch blocks have been shown to demonstrate construct validity. However, to have construct validity, medial branch blocks must be controlled. Single diagnostic blocks carry a false-positive rate of 27%-63% in cervical spine, 55%-58% in the thoracic spine, and 17%-47% in lumbar spine (27, 28, 33-35, 37-41, 44, 75-79). Patients may report relief of pain after a diagnostic block for reasons other than the pharmacologic action of drug administered (30). Thus, it is essential to know the true positive response in every individual case. The validity of controlled comparative local anesthetic blocks for facet joint diagnostic blocks was confirmed with placebo-controlled diagnostic blocks (30, 31).

Confounding Factors

Of the studies reviewed, four articles evaluated diagnostic validity of facet joint blocks under multiple confounding conditions (35, 98-100). All four articles met criteria for inclusion by both AHRQ and QUADAS. Table 1 details these studies and includes methodological quality criteria.

False-positive rate of diagnostic facet joint blocks was evaluated in two groups of patients: with somatization disorder or without such a diagnosis (98). This study showed that somatization or other psychological factors including depression and generalized anxiety disorders failed to influence the diagnostic validity of lumbar facet joint blocks.

The diagnostic validity and therapeutic value of medial branch blocks with or without an adjuvant was also evaluated (35). This study noted no difference in the capacity to diagnose facet joint pain with local anesthetics administered alone or with mixtures of Sarapin and methylprednisolone.

Effect of sedation was evaluated in two prospective, randomized, double blind, placebo-controlled studies (99, 100). These studies showed that conscious sedation with midazolam or fentanyl is a confounding factor in the diagnosis of cervical or lumbar facet joint pain in patients with chronic neck or low back pain. However, these studies suggested that if strict criteria, including pain relief and ability to perform prior painful movements, is used as the standard for evaluating the effect of controlled local anesthetic blocks, the diagnostic validity of facet joint nerve blocks may be preserved. These confounding factors were less significant for lumbar facet joint pain than cervical facet joint pain. If 80% pain relief with ability to perform prior painful movements is used as the criterion standard in cervical spine, an intravenous preoperative sedative dose of an opioid, such as fentanyl, or an anxiolytic agent, such as midazolam, is no more likely to cause a small proportion of patients to report false-positive pain relief with active motion testing than sodium chloride placebo.

Criterion Standard

No tissue diagnosis (biopsy or autopsy) techniques are available to diagnose facet joint pain and confirm specificity and sensitivity of medial branch blocks. However, pain relief and stability of the diagnosis over a long period of time with long-term follow up are employed as the criterion standards and are accepted across multiple medical disciplines (74).

Several studies evaluating the effectiveness of various therapeutic modalities have shown the existence of facet joint pain. Furthermore, Manchikanti et al (97) established the diagnostic validity of lumbar medial branch blocks on long-term follow-up at two years after the initial diagnosis of lumbar facet joint pain in patients with chronic low back pain.

Diagnosis of Facet Joint Pain

Reliability of clinical history, physical examination, medical imaging, and other evaluations have been shown to be poor (34). Revel et al (67, 68) found that a cluster of clinical signs were valuable in predicting the results of an initial screening facet joint block. They suggested that these clinical findings are unsuitable for diagnosis, but may be of value in selecting patients for diagnostic blocks of the lumbar facet joints. Two studies (34, 69) refuted these findings utilizing controlled, comparative local anesthetic blocks. Schwarzer et al (49, 56) evaluated the role of CT scanning and bone scintigraphy in chronic low back pain and showed poor correlation with facet joint injections.

Schwarzer et al (51) and Manchikanti et al (34) evaluated various clinical findings to diagnose facet joint pain and concluded that they were unable to diagnose facet joint pain based on previous assumptions. Study characteristics are illustrated in Table 2.

Prevalence

Multiple publications were examined to evaluate the diagnostic validity of facet joint blocks. Only prospective studies employing fluoroscopic guidance, small volume injectate (less than 1 mL), placebo-controlled or comparative local anesthetic blocks were selected for review. Evaluations, which were duplicates or utilized single blocks only, were excluded.

Of the 16 studies meeting the inclusion criteria (32-44, 76-78), 12 evaluated lumbar facet joint pain, two evaluated thoracic facet joint pain, and five evaluated cervical facet joint pain. Two groups separately reported prevalence estimates for lumbar and cervical facet joint pain. Prevalence of thoracic facet joint pain is based on the reports of one group; this data has not been replicated. Details with study characteristics and methodological quality criteria are listed in Tables 3 to 5.

Table 1. *Description studies evaluating confounding factors*

Study	# of Subjects	Inclusion/Exclusion/ Subject Characteristics	Interventions & Variables	Outcome measures	Results
Manchikanti et al (35) Prospective AHRQ - 3/5 QUADAS - 10/14	180	Age: 18-90 yrs. LBP +/- leg pain. Failed conservative treatment. No neurologic signs. No prior blocks. Single interventional pain management practice.	Double MBB: Interval: 2-4 weeks, Volumes 0.4-0.6 ml, 3 groups: 60 each I - LA (1% L & 0.25% B) II - LA +Sarapin III - LA+Sarapin+ Depomedrol U/L blocks: 33% B/L blocks: 67% Sedation: mild with midazolam	≥75% pain relief in symptomatic area for duration of anesthetic used and bupivacaine (B) effect longer than lidocaine (L) effect	Prevalence: Average 36% I - 38% (95% CI 26%-50%) II - 32% (95% CI 20%-44%) III - 38% (95% CI 26%-50%) False-positive rate of single blocks: Average 25% I - 22% (95% CI 9%-35%) II -27% (95% CI 13%-41%) III -27% (95% CI 13%41%)
Manchikanti et al (98) Prospective AHRQ - 4/5 QUADAS - 12/14	100	>6 months LBP +/- lower limb pain. Age: 18-90 yrs. Failed conservative treatment. No neurologic signs No definitive diagnosis on radiologic test or neuro-physiologic test. MCMI-II to classify into 2 groups: Gp I: (50) non somatization GpII: (50) somatization Single interventional pain management practice	Double MBB: Interval: 2-4 weeks Volumes: 0.4-0.6 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25% Sedation: mild with midazolam	Pain scores Definite response: >80% pain relief in symptomatic area for >45 minutes with lidocaine & 2 hrs. or more after Bupivacaine	Prevalence I - 44% (95% CI 30%-58%) II - 38% (95% CI 24%-52%) False- positive rate single blocks: I - 29% (95% CI 11%-46%) II - 26% (95% CI 10%-42%)
Manchikanti et al (99) Randomized, double-blind, placebo-controlled AHRQ - 5/5 QUADAS - 14/14	180	Chronic neck pain ≥ 1-year. Facet joint pain diagnosed by controlled, comparative local anesthetic blocks. Previously treated with therapeutic medial branch blocks. Presented for repeat treatments after a period of pain relief. Single interventional pain management practice	Subjects randomized to one of the three groups. Double blinded intravenous administration of one of the 3 solutions to maximum dose as follows: G1 - 5ml saline GII - 5mg midazolam GII - 250mcg fentanyl	Outcomes at baseline and after administration of 1 of the 3 solutions Outcome measures: numeric pain scale, proportion of pain relief, and ability to perform prior painful movements.	IV sedation with midazolam or fentanyl is a confounding factor in cervical facet joint pain diagnosis. If >80% pain relief with ability to perform prior painful movements is used as the standard for evaluating the effect of controlled local anesthetic blocks, the diagnostic validity of cervical facet joint nerve blocks may be preserved.
Manchikanti et al (100) Randomized, double-blind AHRQ - 5/5 QUADAS - 14/14	180	Chronic, low back pain of at least 2 years' duration. Patients with facet joint pain confirmed by controlled, comparative local anesthetic blocks of medial branches. All subjects treated previously with lumbar facet joint nerve blocks and were presenting for repeat treatment after a significant period of symptom relief. Single interventional pain management practice	The design consisted of a placebo group receiving sodium chloride solution and two experimental groups receiving either midazolam or fentanyl. Subjects randomized to one of the three groups to receive intravenously in a double blind fashion one of the 3 solutions with maximum doses: G1 - 5ml saline GII - 5mg midazolam GII - 250mcg fentanyl	Outcomes at baseline and after administration of 1 of the 3 solutions Outcome measures: numeric pain scale, proportion of pain relief, and ability to perform prior painful movements.	IV sedation with midazolam or fentanyl is a confounding factor in the diagnosis of lumbar facet joint pain. If strict criteria including pain relief and ability to perform prior painful movements are used as the standard for evaluating the effect of controlled local anesthetic blocks, the diagnostic validity of lumbar facet joint nerve blocks may be preserved.

Based on the results of these studies, facet joints have been implicated as a source of chronic spinal pain in 15%-45% of a heterogeneous group of patients with chronic low back pain (32-40), 42%-48% of the patients with thoracic pain (40, 41), and 54%-67% of the patients with chronic neck pain (39, 40, 42-44). A lower prevalence of facet joint pain was reported in individuals <65 years (30%) compared to >65 years age (52%) (76), and in males (38%) compared to females (43%) (102).

Table 2. *Characteristics of studies evaluating accuracy of non-interventional diagnostic techniques*

Study	# of Subjects	Inclusion/Exclusion /subject Characteristics	Interventions & Variables	Outcome measures	Results
Revel et al (67) Prospective AHRQ - 4/5 QUADAS - 12/14	51	Chronic low back pain. 40 patients included and 11excluded due to unsuccessful intraarticular injection	Single intraarticular facet joint injection with lignocaine and extraarticular injections with corticosteroid; 2-6 joints injected in one session. Ninety clinical variables collected 1 week prior to injection	Positive response: >75% pain relief 30 minutes after last facet joint injection Correlation and identification of predictors of a good response and confirmation of diagnosis of lumbar facet joint pain.	81.8% sensitivity and 77.8% specificity for presence of 4 of the 7 variables in same patient, 7 variables were more frequent in the responder group: older age, absence of exacerbation by coughing, relief when recumbent, absence of exacerbation by forward flexion and when raising from flexion, absence of worsening by hyperextension, and extension-rotation.
Revel et al (68) Prospective, randomized, double-blind AHRQ - 4/5 QUADAS - 12/14	80	LBP>3 months VAS>30 mm on day of injection Seven clinical criteria: age>65; pain relief on recumbency; no pain increase by cough, forward flexion, deflexion, hyperextension, extension-rotation	Random select for ZJI with Lidocaine/ or saline injection Excluded unsuccessful injections Extraarticular steroids in all	Pain relief after Single ZJI with Lidocaine (LI) or normal saline (SI) in group with & without Revel's clinical criteria Positive response: <25% of initial VAS grade	Revel's clinical criteria identified 92% of responders and 80% of non-responders. Those responding had at least 5 clinical criteria p<0.002
Manchikanti et al (34) Prospective AHRQ - 3/5 QUADAS - 11/14	200	>6 months LBP +/- leg pain Failed conservative treatment No neurologic signs No prior blocks Age: 18-90 yrs M/F: 80/120 Post trauma: 49% Post laminectomy: 25% Single interventional pain management practice	Double medial branch block Interval: 2 weeks Volumes: 0.4-0.6 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25% Sedation: mild U/L block: 34% B/L block: 66% Revel's criteria: age>65; Pain relief on recumbency; no pain increase by cough, forward flexion, deflexion, hyperextension, external rotation	Percentage pain relief and duration of pain relief after first and second blocks >75% pain relief in symptomatic area for duration of anesthetic used and Bupivacaine effect longer than Lidocaine effect	Lidocaine positive: 127(64%) alse-positive: 37% (95% CI 28%- 46%) Prevalence: 42% (95% CI 35%-49%) No correlation with Revel's criteria Significant negative correlation with post laminectomy, history of occupational injury, back pain on SLR in double block positive group
Laslett et al (69) Prospective, physical therapist, blinded AHRQ - 4/5 QUADAS - 12/14	151 enrolled 116 completed 35 excluded	Ch LBP +/-Lower limb pain Measurements: VAS: current, best, worst pain; Roland Morris disability; Zung Depression Index; MSPQ; DRAM; Revel's criteria Private radiology practice	Zygapophysial joint injection or medial branch block with 0.5 ml of 2% Lidocaine Confirmatory MBB with 0.75% Bupivacaine in positive responders	Positive response: pain reduction or abolition for 1½ hours after lidocaine and for >4 hours after bupivacaine in positive responders	Revel's criteria have no correlation with facet joint pain
Schwarzer et al (51) Prospective AHRQ - 3/5 QUADAS - 11/14	176	All patients with chronic low back pain without history of previous lumbar surgery. Site: radiology practice and specialist spine practice	Those patients responding to the first series of blocks were given confirmatory blocks using bupivacaine	Correlate the clinical criteria as described by Fairbank et al and Helbig and Lee for zygapophysial joint pain.	None of the clinical features tested were found to be associated with response to the confirmatory block.
Schwarzer et al (56) Prospective, placebo-controlled cross-sectional, analytic study AHRQ - 4/5 QUADAS - 12/14	63	63 patients with low back pain lasting for longer than 3 months. 6 were excluded from evaluation because of unsuccessful injection into the joints as planned.	All patients underwent computed tomography and placebo-controlled blocks of the zygapophysial joints at L3/4, L4/5, and L5/S1. Three independent, masked radiologists scored the zygapophysial joints of all images.	Interobserver agreement with intraclass correlation coefficient using total joint scores for all 3 assessors	Computed tomography has no place in the diagnosis of lumbar zygapophysial joint pain

Table 3. *Study characteristics evaluating prevalence of cervical facet joint pain*

Study	# of Subjects	Inclusion/Exclusion / subject Characteristics	Interventions & Variables	Outcome measures	Results
Manchikanti et al (39) Prospective AHRQ - 3/5 QUADAS - 10/14	120	>6 months NP+LBP Age: 18-90 yrs Failed conservative treatment No definite diagnosis No neurologic signs No prior blocks Single interventional pain management practice	Double MBB: Interval: 3-4 weeks Volumes: 0.5 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Pain relief, and ability to perform previously painful movements	Prevalence: 67% (95% CI 58%-75%)
Manchikanti et al (40) Prospective AHRQ - 3/5 QUADAS - 11/14	255 of 500 patients	>6 months nonradicular pain Age: 18-90 yrs Failed conservative treatment No neurologic findings Single interventional pain management practice	Double MBB: Interval: 3-4 weeks Mild IV sedation with Midazolam Volumes: 0.5 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25% Sedation: mild with midazolam	Pain relief and ability to perform previously painful movements	Prevalence Cervical: 55% (95% CI 49%-61%)
Barnsley et al (42) Prospective, double-blind AHRQ - 4/5 QUADAS - 13/14	50 7 withdrew reasons given 5 did not complete blocks	Age>18years NP> 3 months Following MVA Failed conservative treatment Tertiary referral unit	Double MBB Interval: 2 weeks Volumes: 0.5 ml LA VAS, McGill, pain diagrams Psychologic symptom check list SCL-90R	Degree / duration of pain relief	Prevalence: 54% (95% CI 40%-68%)
Lord et al (43) Randomized, controlled, double-blind, placebo-controlled Independent observer to corroborate needle tip position Blinding of subject, & operator to agent sequence AHRQ - 4/5 QUADAS - 13/14	68 11 withdrew 5 did not complete	Chronic neck pain and headache after whiplash Tertiary referral unit	TON block to exclude C2-3 facet pain 3 injections distal to C2-3 facet joint Double blind, random order Volumes: 0.5 ml 1st injection: 2% Lidocaine or 0.5%Bupivacaine 2nd and 3rd injections: saline or anesthetic not used in first injection VAS, McGill, SCL-90R	Pain relief extent and duration on telephone contact Positive response: Complete relief + reproducible relief with local anesthetics but not placebo	50% prevalence of C2-3 facet pain (95% CI 29%-71%) Overall prevalence (including C2-3 facet joint): 60% (95% CI 46%-73%) Most common facet levels: C2-3 and C5-6
Manchikanti et al (44) Prospective AHRQ - 3/5 QUADAS - 10/14	106	>6 months NP+/-Headaches Age: 18-90 yrs Failed conservative treat No neurologic signs No prior blocks Single interventional pain management practice	Double MBB: C2-3 to C6-7 levels Interval: 2-4 weeks Volumes: 0.5 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25% Sedation: mild with midazolam	Pain scores and ability to perform previously painful movements	Prevalence: 60% (95% CI 50%-70%)

Table 4. *Study characteristics evaluating prevalence of thoracic facet joint pain*

Study	# of Subjects	Inclusion/Exclusion /subject Characteristics	Interventions & Variables	Outcome measures	Results
Manchikanti et al (40) Prospective AHRQ - 3/5 QUADAS - 11/14	72 of 500 patients	>6 months nonradicular chronic NP, TP, LBP or combination Age: 18-90 yrs Failed conservative treatment No neurologic findings Single interventional pain management practice	Double MBB: Interval: 3-4 weeks Mild IV sedation with Midazolam Volumes: 0.5 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Pain relief and ability to perform painful movements	Prevalence Thoracic: 42% (95% CI 30%-53%)
Manchikanti et al (41) Prospective AHRQ - 3/5 QUADAS - 10/14	46	>6 months Non radicular TP Age: 18-90 yrs Failed conservative treat Single interventional pain management practice	Double MBB: Interval: 3-4 weeks Mild IV sedation with Midazolam Volumes: 0.5 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Pain relief and ability to perform previously painful movements	Prevalence: 48% (95% CI 34%-62%)

A history of trauma/occupational injury and prior lumbar spine surgery negatively correlated with prevalence of facet joint pain (33, 34, 77, 102) while smoking (102), somatization, anxiety, or depression (98) did not increase the prevalence of facet joint pain.

Complications

There was one vasovagal episode and short duration procedure-related discomfort reported by one study (105). No ma-

Table 5. *Study characteristics evaluating prevalence of lumbar facet joint pain*

Study	# of Subjects	Inclusion/Exclusion /subject Characteristics	Interventions & Variables	Outcome measures	Results
Schwarzer et al (32) Prospective AHRQ - 4/5 QUADAS - 12/14	176 71 completed	LBP pain severe enough to refer / no prior surgery/ no neuro sign Site: radiology practice+ Specialist spine private practice	Double MBB 2% lidocaine 0.5 mL 0.5% bupivacaine 0.5 mL	VAS Pain scores, and ability to perform painful movements.	Prevalence: 15% (95% CI 10%-20%)
Manchikanti et al (33) Prospective AHRQ - 3/5 QUADAS - 8/14	120	>6 months LBP +/- leg pain No neurologic signs No prior blocks Single interventional pain management practice	Double MBB Interval: 2 weeks Volumes: 0.4-0.6 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Percentage pain relief and duration of pain relief after first and second blocks, and ability to perform painful movements.	Prevalence: 45% (95% CI 36%-54%)
Manchikanti et al (34) Prospective AHRQ - 3/5 QUADAS - 11/14	200	>6 months LBP +/- leg pain Failed conservative treat No neurologic signs No prior blocks Single interventional pain management practice	Double MBB Interval: 2 weeks Volumes: 0.4-0.6 ml 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Percentage pain relief and duration of pain relief, and ability to perform painful movements.	Prevalence: 42% (95% CI 35%-49%)
Manchikanti et al (35) Prospective, patient self selected group AHRQ - 3/5 QUADAS - 10/14	180	Age: 18-90 yrs LBP +/- leg pain Failed conservative treatment No neurologic signs No prior blocks Single interventional pain management practice	Double MBB: Interval:2-4 weeks Volumes 0.4-0.6 ml 3 groups: 60 /group Gr I: LA (1% Lidocaine & 0.25% Bupivacaine) GrII: LA +sarapin Gr III: LA+ sarapin+depomedrol	Percentage pain relief and duration of pain relief, and ability to perform painful movements.	Prevalence: 36% Gp I: 38% (95% CI 26%-50%) Gp II: 32% (95% CI 20%-44%) Gp III: 38% (95% CI 26%-50%)
Schwarzer et al (36) Prospective, single-blind Subjects blind to agent and sequence of joint injections AHRQ - 4/5 QUADAS - 12/14	63 enrolled 57 completed	18-80 years with chronic mechanical LBP; no known cause on imaging; failed conservative treatment Subjects referred by rheumatology at tertiary referral teaching hospital	1st inj: 0.5 ml saline inj in paraspinal muscle (placebo) Subsequent injections: intraarticular facet joint with 0.3 contrast+ 0.5% Bupivacaine Volume <1.5 ml	Pain scores, intraobserver agreement on range of motion tests	Prevalence 40% L4-5 and L5-S1 facet joints most common
Manchikanti et al (37) Prospective AHRQ - 4/5 QUADAS - 10/14	120	18-90 years with chronic low back pain and no neurological deficits. Single interventional pain management practice	Double blocks with 1% Xylocaine and 0.25% bupivacaine	Percent and duration of pain relief with ability to perform painful movements	Prevalence: 40% (95% CI 31%-49%)
Manchikanti et al (38) Prospective AHRQ - 4/5 QUADAS - 12/14	300	Chronic low back pain With involvement of: single region: n=150 multiple regions: n=150 Single interventional pain management practice	Double medial branch blocks with 1% lidocaine and 0.25% bupivacaine.	Pain relief and ability to perform previously painful movements.	Prevalence: I : 21% (95% CI 14%-27%) II : 41% (95% CI 33%-49%)
Manchikanti et al (39) Prospective AHRQ- 3/5 QUADAS - 10/14	120	>6 months Neck pain + LBP Age: 18-90 yrs Failed conservative treatment No definite diagnosis Single interventional pain management practice	Double medial branch block 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Pain relief and ability to perform previously painful movements	Prevalence: 40% (95% CI 31%, 49%)
Manchikanti et al (40) Prospective AHRQ - 3/5 QUADAS - 11/14	397 of 500 patients	>6 months nonradicular LBP Age: 18-90 yrs Failed conservative treatment No neuro findings Single interventional pain management practice	Double medial branch block 1st: Lidocaine 1% 2nd: Bupivacaine 0.25%	Pain relief and ability to perform painful movements	Prevalence: 31% (95% CI 27%-36%)

jor complications were reported in any of the studies.

False-Positive Rates

After careful reading, 14 relevant studies evaluating false-positive rates were included for evidence synthesis. All of the studies reported false-positive rates either independently or in conjunction with other parameters. The details are shown in Table 6 (33-35, 37-41, 44, 75-79). These studies implicated single blocks as a source of false-positive results in 27%-63% of patients in the cervical spine (39, 40, 44, 75), 55%-58% of the patients in the thoracic spine (40, 41), and 17%-47% in the lumbar spine (33-35, 37-40, 76-79).

Strength of Evidence

Based on review of all available studies meeting our inclusion criteria, there is strong evidence that controlled diagnostic facet joint blocks establish diagnosis of facet joint pain in chronic spinal pain of cervical and lumbar origin, and moderate evidence for thoracic facet joint pain.

Discussion

This systematic review provides moderate to strong evidence that controlled diagnostic facet joint blocks are safe, valid, and reliable, while uncontrolled facet joint injections are associated with a significant and variable false-positive rate. When performed under fluoroscopic visualization, utilizing IASP criteria (85), facet joint blocks are accurate and clinically useful in the diagnosis and therapeutic management of chronic spinal pain. The diagnostic accuracy of facet or zygapophysial joint blocks is strong for cervical and lumbar facet joints, and moderate for thoracic facet joints. In contrast to other available diagnostic techniques, needle diagnostic interventional techniques can diagnose facet joint pain with a high level of certainty.

Based on the present systematic review, we conclude facet joint pain is seen in 15%-45% of patients with chronic low back pain (32-40), 42%-48% of the patients with mid back or upper back pain (40, 41), and 54%-67% of patients with chronic neck pain (39, 40, 42-44). False-positive rates with single blocks are 17%-47% in the lumbar spine (33-35, 37-40, 76-79), 27%-63% in the cervical spine (39, 40, 44, 75), and 55%-58% in the thoracic spine (40, 41) (Table 6).

The strength of this review is based on its compliance with stringent AHRQ (92) and QUADAS (93) criteria for evaluation of diagnostic tests. According to AHRQ criteria, each study was evaluated in five key domains and essential elements: study population, adequate description of the test, appropriate reference standard, blinded comparison of test and reference, and avoidance of verification bias. All studies met at least three criteria for inclusion as recommended by AHRQ. Fulfilling all five AHRQ criteria is difficult, partly because some of the criteria are not relevant to interventional diagnostic techniques. QUADAS, recently developed by Whiting et al (93), is an evidence-based tool for quality assessment of studies of diagnostic accuracy. The tool consists of a set of 14 items, phrased as questions, each of which should be scored as Yes, No, or Unclear. The items cover bias, variability, and to a certain extent, the quality of reporting. The majority of items included in QUADAS relate to bias (items 3-7, 10-12, and 14), two items relate to variability (items 1 and 2), and three to reporting (items 8, 9, and 13). The tool is simple and quick to complete and does not incorporate a quality score. We considered QUADAS as an appropriate tool and therefore used it for evaluating the diagnostic accuracy of studies in this systematic review. A methodological score was determined for each study based on QUADAS.

Hildebrandt (73), Saal (74), North et al (71), Hogan and Abram (72), Bogduk (27), Boswell et al (28), and Manchikanti et al (2) described challenges related to diagnostic blocks. North et al (71) examined the specificity and sensitivity of a battery of local anesthetic blocks in a series of 33 patients with a complaint of sciatica, attributable to spinal disease. In a blinded randomized sequence, subjects received three different types of nerve blocks and subcutaneous injection of 0.5% bupivacaine. The nerve blocks were significantly more effective than control injection of an identical volume of 3 mL of 0.5% bupivacaine subcutaneously in the lumbar area. A majority of the patients reported temporary relief not only with lumbosacral nerve root blocks, and medial branch posterior primary ramus blocks, but also with sciatic nerve blocks (distal or collateral to the pathology), lending support to the study hypothesis that specificity of diagnostic nerve blocks is low and false-positive results are common. Strongest association was observed between relief by sciatic nerve block and relief by medial branch posterior primary ramus or facet block; no association was noted between the results of blocks and clinical findings including imaging studies. These authors concluded that uncontrolled local anesthetic blocks had a limited role in the diagnostic evaluation of sciatica and referred pain syndromes in general and that negative blocks as a pattern of response may have some predictive value, but isolated, positive blocks are nonspecific. However, they conceded that this lack of specificity might be advantageous in therapeutic applications. Thus, North et al (71) affirmed the necessity of controlled diagnostic blocks, while discrediting uncontrolled diagnostic blocks.

A criticism with regards to diagnostic facet joint blocks is related to the criterion standard. It is recognized that the accuracy of a diagnostic test is best determined by comparing it to an appropriate reference standard such as biopsy, surgery, autopsy, or long-term follow-up (106, 107). A gold or criterion standard allows accurate comparison of the capacity of a given diagnostic test to yield positive results when the clinical condition is present, and negative results when the clinical condition is not present. Thus, a gold or criterion standard facilitates accurate determination of the specificity and sensitivity of a test. Tissue confirmation of presence or absence of a disease at surgery, biopsy, or autopsy has served as the accepted criterion standard across multiple medical disciplines; it is, however, not applicable to diagnostic facet joint nerve blocks. There is no histopathologic marker and hence no justification for surgical intervention or biopsy to confirm or exclude facet joint pain. Consequently, as described by many authors, stability of the diagnosis over a long period of time with long-term follow-up is used as a criterion standard. In addition, for most interventional techniques, abolition or reproduction of the patient's pain symptoms must be considered as a criterion standard (74).

Saal (74) compared precision diagnostic injections to physical examination tests rather than most laboratory tests used in clinical medicine. Needle diagnostic injection techniques have several benefits as compared to traditional diagnostic methods: ability to access facet joints and nerves to the joints, normally inaccessible to palpation; ability to target facet

Table 6. *Data of prevalence with controlled diagnostic blocks and false-positive rates of single facet joint blocks in cervical, thoracic, and lumbar regions*

Study	Region	# of Subjects	Type	Prevalence	False-Positive Rate
Barnsley et al (75) 1993	C	55	RCT	NA	27% (95% CI 15%-38%)
Barnsley et al (42) 1995	C	50	P, DB	54% (95% CI 40%-68%)	NA
Lord et al (43) 1996	C	68	RCT, DB, PC	60% (95% CI 46%-73%)	NA
Manchikanti et al (44) 2002	C	106	P	60% (95% CI 50%-70%)	40% (95% CI 25%-56%)
Manchikanti et al (39) 2002	C	120	P	67% (95% CI 58%-75%)	63% (95% CI 48%-78%)
Manchikanti et al (40) 2004	C	255 of 500 patients	P	55% (95% CI 49%-61%)	63% (95% CI 54%-72%)
Manchikanti et al (40) 2004	T	72 of 500 patients	P	42% (95% CI 30%-53%)	55% (95% CI 39%-78%)
Manchikanti et al (41) 2002	T	46	P	48% (95% CI 34%-62%)	58% (95% CI 38%-78%)
Schwarzer et al (32) 1994	L	176	P	15% (95% CI 10%-20%)	NA
Schwarzer et al (79) 1994	L	176	Subjects from previous study	15%	38% (95% CI 30%-46%)
Schwarzer et al (36) 1995	L	63	P, SB	40% (95% CI 27%-53%)	NA
Manchikanti et al (33) 1999	L	120	P	45% (95% CI 36%-54%)	41% (95% CI 29%-53%)
Manchikanti et al (34) 2000	L	200	P	42% (95% CI 35%-49%)	37% (95% CI 28%-46%)
Manchikanti (35) 2000	L	180	P Psuedo randomized	Average 36% I: 38% (CI 26%-50%) II: 32% (CI 20%-44%) III: 38% (CI 26%-50%)	Average 25% I: 22% (CI 9%-35%) II: 27% (CI 13%-41%) III: 27% (CI 13%-41%)
Manchikanti et al (37) 2001	L	120	P	40% (95% CI 31%, 49%)	47% (95% CI 35%, 59%)
Manchikanti et al (76) 2001	L	Gp I (≤65 years)=50 Gp II(≥65 years)=50	P	I: 30% CI 17%-43%) II: 52% CI 38%-66%)	I: 26% CI 11%-40%) II: 33% CI 14%-35%)
Manchikanti et al (77) 2001	L	Gp I (no prior surgery)=50 Gp II (prior surgery)=50	P	I: 44% (95% CI 31%-49%) II: 32% (95% CI 19%-45%)	I: 36% (95% CI 18%-54%) II: 24% (95% CI 9%-38%)
Manchikanti et al (78) 2001	L	Gp I (BMI<30)=50 Gp II (BMI ≥30)=50	P	I: 36% (95% CI 22%-50%) II: 40% (95% CI 26%-54%)	I: 44% (95% CI 26%-61%) II: 33% (95% CI 16%-51%)
Manchikanti et al (39) 2002	L	120	P	40% (95% CI 31%-49%)	30% (95% CI 20%-40%)
Manchikanti et al (38) 2003	L	GI: Single region =150 GII: multiple regions =150	P	I: 21% (95% CI 14%-27%) II : 41%(95% CI 33%-49%)	I: 17% (95% CI 10%-24%) II : 27% (95% CI 18%-36%)
Manchikanti et al (40) 2004	L	397 of 500 patients	P	31% (95% CI 27%-36%)	27% (95% CI 22%-32%)

C=Cervical; T=Thoracic; L=Lumbar; RCT: Randomized Controlled Trial; P = prospective; RA = randomized; PC = placebo controlled; DB = double blind; NA = not available

joint/nerves selectively and accurately under fluoroscopic visualization; physiologic assessment of evoked pain and analgesic responses; and finally, these blocks can be submitted to critical appraisal in multiple controlled trials. Provocation of pain, however, is considered to be ineffective in evaluating facet joint pain (104), although it may be of value for other structures. These blocks have been critically evaluated in multiple controlled trials, as well in a previous systematic review, and multiple systematic analyses. Consequently, the patient and physician can be assured that the validity of the test is maintained in the majority of the patients when proper technique and selection criteria are employed.

This systematic review shows that controlled comparative local anesthetic or placebo-controlled diagnostic facet joint blocks are safe, accurate and provide reproducible results, whereas single uncontrolled blocks are unreliable.

Conclusion

Diagnostic facet joint blocks are safe, valid and reliable. Based on review of available studies that met inclusion criteria, there is strong evidence that controlled diagnostic blocks reliably distinguish painful from painless facet joints. This diagnostic information is useful in the management of chronic spinal pain.

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Appendix A. *Domains for diagnostic studies developed by the Agency for Healthcare Research and Quality (AHRQ) (92)*

Key domains are in italics

Study Population
Adequate Description of Test
Appropriate Reference Standard
Blinded Comparison of Test and Reference
Avoidance of Verification Bias

Appendix B. *Elements for diagnostic studies developed by the Agency for Healthcare Research and Quality (AHRQ) (92)*

Elements appearing in italics are those with an empirical basis. Elements appearing in bold are those considered essential to give a system a Yes rating for the domain.

- ***Subjects similar to populations in which the test would be used and with a similar spectrum of disease***
- ***Details of test and its administration sufficient to allow for replication of study***
- ***Appropriate reference standard ("gold standard") used for comparison***
- Reference standard reproducible
- Evaluation of test without knowledge of disease status, if possible
- ***Independent, blind interpretation of test and reference***
- ***Decision to perform reference standard not dependent on results of test under study***

Appendix C. *Items utilized for assessment of quality of individual articles of diagnostic studies by QUADAS tool (93)*

1. Was the spectrum of patients representative of the patients who will receive the test in practice?
2. Were selection criteria clearly described?
3. Is the reference standard likely to correctly classify the target condition?
4. Is the time period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?
5. Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?
6. Did patients receive the same reference standard regardless of the index test result?
7. Was the reference standard independent of the index test (i.e. the index test did not form part of the reference standard)?
8. Was the execution of the index test described in sufficient detail to permit replication of the test?
9. Was the execution of the reference standard described in sufficient detail to permit its replication?
10. Were the index test results interpreted without knowledge of the results of the reference standard?
11. Were the reference standard results interpreted without knowledge of the results of the index test?
12. Were the same clinical data available when test results were interpreted as would be available when the test is used in practice?
13. Were uninterpretable/intermediate test results reported?
14. Were withdrawals from the study explained?

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