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Review

Systematic Review Of Diagnostic Utility Of Facet (Zygapophysial) Joint Injections In Chronic Spinal Pain: An Update

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Background: A 2-year review of literature from October 2004 to December 2006 was completed to update current scientific evidence on diagnostic utility of facet joint injections. Diagnostic injections are employed to diagnose facet joint pain because available techniques cannot identify the pain generating structure in patients with chronic spinal pain. There is no physical examination technique, laboratory test, or imaging modality that can precisely identify the spinal structure causing pain, distinguish the culprit from a variety of potential targets, and predict response to a therapeutic intervention. Zygapophysial joint injections, commonly called facet injections (intra-articular joint injections and medial branch blocks) are local anesthetic injections of the facet joint or its nerve supply. These are diagnostic procedures used to determine if pain is arising from facet joints, distinguish painful from non-painful joints and prognosticate response to therapeutic facet joint interventions. Diagnostic injections must meet the cardinal features of a diagnostic test i.e., accuracy, safety, and reproducibility. Accuracy is based on comparison with a "gold standard" to confirm presence or absence of a disease. There is, however, no available gold standard to measure presence or absence of pain. Hence, there is a degree of uncertainty concerning the accuracy of diagnostic facet joint injections.

Objectives: Evaluate and update available evidence (2004 to 2006) relating to clinical utility of facet joint injections (intraarticular and medial branch blocks) in diagnosing chronic spinal pain of facet joint origin.

Study Design: Review of the literature for clinical studies on efficacy and utility of facet joint/nerve injections in diagnosing facet joint pain according to Agency for Healthcare Research and Quality (AHRQ) and Quality Assessment Studies of Diagnostic Accuracy (QUADAS) criteria. The level of evidence was classified as conclusive (Level I), strong (Level II), moderate (Level III), or limited (Level IV).

Methods: Computerized database search (2004 to 2006) of PUBMED, EMBASE, CINAHL, and Web of Knowledge was conducted to identify studies on facet joint pain and diagnostic interventions. Abstracts, reviews, book chapters, case reports, studies based on single blocks or blocks without radiologic control, and studies describing techniques were excluded. Prospective studies were given priority over retrospective studies.

Results: There is no change in the strength of evidence for facet joint diagnostic injections. There is strong evidence for controlled comparative local anesthetic facet joint injections or medial branch blocks in the diagnosis of neck and low back pain and 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 joints (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.

Key words: Chronic spinal pain, neck pain, low back pain, cervical facet joint, thoracic facet joint, lumbar facet joint, zygapophyseal joint, medial branch block, intraarticular injection

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A systematic review of the diagnostic utility of facet or zygapophysial joint injections in chronic spinal pain was performed in 2004 (1). Spinal pain is a common cause of chronic pain and disability. Chronicity and disability from spinal pain are multifactorial, and associated with non-specific diagnosis and suboptimal outcomes. However, chronic refractory spinal pain continues to pose a peculiar diagnostic challenge because of multiple putative pain sources, overlapping clinical features, and non-specific 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.

Facet joints are a well-recognized cause 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 and 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 and-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). There are however, no specific clinical markers of facet joint pain.

Conventional clinical and radiologic techniques used to diagnose appendicular joint pain are unreliable in diagnosing zygapophyseal (facet) joint pain (1,66-113). Controlled local anesthetic blocks of the facet joint or its nerve supply are routinely employed to diagnose facet joint pain. The rationale for these blocks is that anesthetic blockade of a painful joint will abolish pain arising from that joint for the duration of the anesthetic effect, while anesthetic blockade of a nonpainful joint will not alter the pain report. The probability that the blocked joint is the actual source of pain is increased if repeating the block with an anesthetic agent that has a different duration of action reproduces the analgesic response (74). To ensure accuracy and validity these blocks must be controlled and verified for delivery of local anesthetic agent and placebo response. Fluoroscopic guidance and contrast enhancement enables precise delivery of local anesthetic agents to target structures. Dual or triple blocks are employed to eliminate placebo responses. Single facet joint injections are not recommended, as they do not control for a false-positive response (74-76,78-80,82,114-132). The placebo controlled technique is considered the gold standard, but has limited clinical utility due to ethical and cost implications. A controlled comparative block with short and long acting local anesthetics is an acceptable alternative strategy (1,74-76,114,115,133,134).

Controlled comparative blocks have been criticized and the accuracy and validity of these precision diagnostic techniques have been questioned (122,123,130,135-138). Although these tests control and verify for location of local anesthetic delivery, they are faulted for assuming that the report and documentation of the magnitude and quality of pain relief are accurate. Because these tests employ subjective criteria i.e., rely on a patient's report of presence or absence of pain following a block, and ability to isolate different painful areas, or differentiate between significant and insignificant pain relief (when pain relief is incomplete) they promote doubt about the accuracy of these procedures.

Hildebrandt (123), in an extensive review on the relevance of diagnostic zygapophysial joint blocks, questioned the anatomic and physiologic premises for neural blockade. Nachemson and Vingård (138) opined that except for imaging studies, all other studies failed to demonstrate clinical utility in assessment of neck or back pain. Ramsey et al (139) believed facet blocks, discography, and diagnostic nerve root infiltration lacked scientific rigor. North et al (121) reported a limited role for uncontrolled local anesthetic blocks in the diagnostic evaluation of sciatica and referred pain syndromes in general. They concluded that negative blocks may have some predictive value, but isolated, positive blocks are non-specific. Leonardi et al (135) described that one rationale for spinal injections is to provide or eliminate pain presumably caused by the target spinal structure; this ostensibly allows a physician to make a better assessment of whether a particular morphologic alteration does or does not cause symptoms. They also described that another rationale is to use spinal injections to support conservative treatment in patients who have pain from nerve root compromise, spinal stenosis, or facet joint osteoarthritis. They concluded that despite the widespread use of these spinal injections, their application is based widely on anecdotal experience and evidence that is not evidence-based.

Waggershauser et al (136) described that in a maximum of 7% of cases, the pain is radicular (4%

due to intervertebral discs and 3% caused by stenosis), in 7% to 15% of cases, the pain's origin is located in the region of the vertebral joints and in up to 15% in the region of the sacroiliac joint. They described that although the overwhelming majority of pain has no clear structural cause, infiltrations of medications and nerve blockades are frequently employed. They also emphasized that the efficacy of these procedures has not been verified in controlled studies with the exception of epidural injection of corticosteroids for radicular pain.

Resnick et al (137) reviewed accuracy and effectiveness of interventional techniques. There is evidence that suggests that facet joint injections can be used to predict outcome after radiofrequency ablation of a facet joint. However, they emphasized that the predictive ability of facet joint injections does not appear to apply to lumbar fusion surgery. However, they commented that no evidence exists to support the effectiveness of facet injections in the treatment of patients with chronic low back pain.

Proponents of diagnostic blocks suggest that precise fluoroscopically guided needle techniques can selectively and accurately target deep and inaccessible spinal structures such as disc, facet joints or spinal nerves and can individually assess each of these structures' contribution to a subject's pain (1,74-76,85,124). These structures can then be selectively blocked with small volumes of appropriately placed local anesthetics, and the delivery of these agents can be controlled and verified to ensure that only the target structure is anesthetized (85). In this manner it can be determined physiologically if the structure is indeed painful or not.

Accuracy of a diagnostic test is described in terms of specificity and sensitivity of the test. Specificity is a relative measure of the prevalence of false-positives, whereas sensitivity is the relative prevalence of false-negative results. None of the tests available in clinical medicine have 100% sensitivity and specificity; there is invariably a degree of uncertainty regarding the accuracy of each and every diagnostic test as applied to an individual clinical case.

Saal (124) considers precision diagnostic spinal injections to be physical examination tests that, unlike most laboratory tests used in clinical medicine, lack an absolute gold standard in the form of a tissue diagnosis for comparison. Although these tests depend on abolition or reproduction of the patient's pain symptoms to make a diagnosis, they should not be regarded as useless or invalid.

Bogduk and McGuirk (72,85-88,140,141) described the accuracy and value of precision diagnostic blocks, proposed an algorithmic approach to diagnosis of chronic spinal pain and defined the role of precision diagnostic blocks in the diagnosis and treatment of chronic low back and neck pain. Boswell et al (66), in an evidence-based evaluation of diagnostic facet joint blocks 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 (75) and Sehgal et al (1), in a systematic review, reported the accuracy of precision, controlled diagnostic blocks in the diagnosis of chronic spinal pain of facet joint origin.

By applying stringent criteria as recommended by International Association for the Study of Pain (IASP) (142) and using controlled diagnostic blocks, construct validity of facet joint blocks is maintained (1,74-84,114-120,125-129,131-134). Face validity of facet joint blocks has been demonstrated in various studies (21,23,24).This systematic review was undertaken to update the literature and determine the accuracy of facet joint blocks in the diagnosis of chronic spinal pain.

Methods

Search Strategy

A computerized database search (October 2004 to December 2006) of PUBMED, EMBASE, CINAHL, and Web of Knowledge was performed. 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/zygapophyseal joints as causes of neck/back pain; facet joint/diagnostic injections; diagnostic joint and nerve injections.

Inclusion Criteria

Prospective and retrospective studies on diagnostic facet joint procedures in patients with spinal pain of >3 months duration were included for review. Studies were included if the injections were fluoroscopically/image guided and controlled for false-positive responses i.e., used comparative control or placebo control blocks. Controlled, double-blind studies were given priority over cohort and observational studies in grading of the evidence. The criterion standard for diagnosis of zygapophysial facet joint pain was at least >50% pain relief for the duration of local anesthetic effect.

Exclusion criteria

Papers excluded from review were anatomical/cadaver studies, studies describing injection techniques, ultrasound guided injections, case reports, chapters, reviews, guidelines, letters, and expert opinions. Studies that failed to exclude a false-positive response, or consisted of injections that were not image guided were not considered for this review. Also excluded were papers on therapeutic facet joint procedures e.g., radiofrequency neurotomy, intraarticular steroid injections, and therapeutic medial branch blocks.

Method of Review

Abstracts obtained from computerized database searches were initially screened for exclusion criteria. Two physician reviewers evaluated and graded articles meeting inclusion criteria for methodologic quality and grading of evidence. AHRQ (Agency for Healthcare Research and Quality) criteria and QUADAS criteria as illustrated in Tables 1 and 2 were employed and all studies fulfilling >3/5 AHRQ criteria and/or > 7/14 QUADAS criteria formed the subject of this review (143,144)

Results

Database searches yielded 44 articles on facet/zygapophysial joints, including 2 articles in press (145-156). Thirty-seven papers were excluded for the reasons shown in Table 3. Two of the 7 studies on controlled comparative local anesthetic blocks described prevalence rates of facet pain and false-positive rates. These studies were similar in methodology, outcomes assessment, and statistical analyses to earlier studies by the same authors. Both studies from the current search were added to the previously established database of 37 studies (1966 to 2004). Salient characteristics of these studies have been described in detail in a previous systematic review by Sehgal et al (1).

Diagnostic Accuracy & Prevalence Studies

There were 2 retrospective studies of which 1 was excluded (145); a second study on prevalence of facet joint pain and false-positive rate of diagnostic facet blocks (131) met criteria and was included in the review. In the retrospective survey of 500 patients with spinal pain, controlled, comparative local anesthetic medial branch blocks revealed that the prevalence of facet joint pain for cervical spine was 39%, thoracic spine was 34% and lumbar spine was 27%. Single lidocaine medial branch blocks had a false-positive rate of 45% in the cervical spine, 42% in the thoracic spine and, and 45% in the lumbar spine. These figures are lower than the previously reported prevalence rates and false-positive rates (118) and most likely are a function of stringent diagnostic criterion i.e., use of 80% or greater pain reduction criterion for a positive response to medial branch blocks.

Table 1. *Domains and elements for diagnostic studies developed by the Agency for Healthcare Research and Quality (AHRQ)*

Study Population	• *Subjects similar to populations in which the test would be used and with a similar spectrum of disease*
Adequate Description of Test	• *Details of test and its administration sufficient to allow for replication of study*
Appropriate Reference Standard	• *Appropriate reference standard (gold standard) used for comparison* • **Reference standard reproducible**
Blinded Comparison of Test and Reference	• **Evaluation of test without knowledge of disease status, if possible** • *Independent, blind interpretation of test and reference*
Avoidance of Verification Bias	• *Decision to perform reference standard not dependent on results of test under study*

[#] *Key domains are in italics*

**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.*

Adapted from ref 143

Table 2. *Items utilized for assessment of quality of individual articles of diagnostic studies by QUADAS tool*

Item	Yes	No	Unclear
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 past 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?	( )	( )	( )

Adapted from ref 144

Table 3. *Articles excluded from review*

Topic of paper	Number
No original data (essay, review, letter)	17
Designs flaw or diagnosed on single injection (one in foreign language)	2
Survey need for conscious sedation	1
Technique only (six studies on ultrasound guided technique)	8
Complication only	7
Not English language	2

Manchikanti et al (132) reported a 16% prevalence of lumbar facet joint pain in a prospective study of 117 post surgical patients. The false-positive rate was 49%.

A retrospective study by Cohen et al (146) evaluated lumbar facet joint pain in soldiers and retirees and sought to determine factors associated with false-positive medial branch blocks. The authors review of medical records of 78 patients undergoing diagnostic medial branch blocks and provocative discography. There were 52 (67%) patients with a negative response (negative blocks) and 26 (33%) with 50% or greater pain relief after single medial branch block who did not respond to subsequent facet RF neurotomy (false-positive). Data on subjects without pain relief after medial branch blocks (negative blocks) and after lumbar radiofrequency neurotomy (false-positive) were analyzed; of 75% of subjects with negative blocks and 3% with false-positive blocks had positive discography. The authors concluded that failure to control for a false-positive response prior to radiofrequency neurotomy resulted in high failure rate. This study exemplifies the importance of excluding false-positives prior to definitive treatments for facet joint pain.

Clinical and Radiological Predictors of Facet Pain

Laslett et al (111) analyzed data from a prospective blinded study of 120 chronic LBP subjects receiving zygapophysial joint blocks (n=151), to identify clinical variables predictive of a positive response to screening facet joint blocks. Pain reduction after screening zygapophysial joint blocks was categorized in 5% increments and diagnostic accuracy values calculated for clinical variables and variable clusters in relation to different pain reduction standards. Seven clinical findings in 4 different combinations (CPR or clinical prediction rules) were determined to be superior at predicting the outcome of a single zygapophysial joint block at 95% pain reduction standard. A combination of clinical variables was found to be highly sensitive in predicting a negative response to the screening zygapophysial joint blocks. In another prospective blind study by the authors (113,147), they sought to determine diagnostic agreement between clinical diagnoses and diagnoses based on available reference standards for known causes of LBP, (e.g., disc or facet, SIJ, hip joint injections, advanced imaging studies, or any combinations of these). The study evaluated 216 LBP subjects and a proportional chance statistic of 33% and kappa statistic of 0.31 were calculated.

Pneumaticos et al (112) prospectively evaluated use of bone scintigraphy with SPECT for identifying patients with low back pain requiring facet joint injections. A total 47 LBP patients were randomized to receive SPECT scan (A) and no scan (B). Subjects with a positive SPECT scan (A1) received facet joint injections at the level reported as abnormal on the SPECT scan. Subjects with negative scan (A2) and those randomized to no scan group (B) underwent facet joint injections at predetermined levels. Thirteen of 15 patients in Gp.A1, 2/16 in Gp.A2, and 5/16 in Gp.B reported >1 SD pain score improvement at one month. Based on the reduction in the number of facets injected from 60 to 27 in Gp A1, Medicare cost was calculated to decrease from $2191 per patient to $1865 with use of SPECT.

Houseni et al (148) demonstrated the potential of fluorodeoxyglucose (FDG) positron emission tomography (PET) in the diagnosis of facet joint arthropathy.

Kim and Wang (149) performed MRI scans and SPECT (single photon emission computed tomography) scans, to study 230 facet joint in patients with facet mediated axial back pain. The authors reported that facet hypertrophy did not predict anormal (positive) SPECT scan, but synovial anormalities correlated with findings on SPECT scans.

Confounding Factors

Conscious sedation during diagnostic injections can modify the pain experience and result in lower pain ratings. Studies by Manchikanti et al (150-153) have demonstrated that conscious sedation may introduce a slight false-positive response due to the analgesic, sedative, and anxiolytic properties of fentanyl and midazolam. This effect can be minimized by employing strict criteria for identifying positive analgesic response as shown previously by the author.

In a recent study, Manchikanti et al (152) examined the confounding influences of conscious sedation on diagnostic injections in subjects with both cervical and lumbar facet pain. Sixty patients with established diagnoses of cervical and lumbar facet pain and presenting for therapeutic medial branch blocks, received in a randomized double blind placebo controlled manner, intravenous saline, midazolam or fentanyl until relaxed/sedated or delivery of maximum predetermined dose. Subjects were evaluated for percentage of pain relief and ability to perform previously painful movements. 5% of subjects in the placebo group, and up to 10% subjects in the active drug group reported

>80% pain relief and were able to perform movements that were painful prior to administration of IV agents. Application of >80% pain reduction criterion standard instead of >50% pain reduction decreased the false-positive response from 15% to 10%. Earlier studies demonstrated placebo and nocebo effects of sedation (150,151) and lack of confounding influence of psychological factors (154).

Safety and Complications

There was one case report of transient paraplegia after a cervical facet joint injection performed without imaging guidance (155). A vasovagal episode and short duration procedure-related discomfort was reported in the past (156). Multiple other complications were reported with infection and bleeding (157-162).

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 adjacent structures that might be an alternative source of pain to the zygapophysial joint (21,23). In addition, medial branch blocks have been shown to protect normal volunteers from pain provoked experimentally from the anesthetized joint (24).

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, 42%-58% in the thoracic spine, and 17%-47% in lumbar spine (1,74-80,82,116-120,125-129,131,132). Patients may report relief of pain after a diagnostic block for reasons other than the pharmacologic action of drug administered (114). 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 (114,115).

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 with long-term follow up are employed as the criterion standards and are accepted across different medical disciplines (1,124,163).

Several studies evaluating the effectiveness of various therapeutic modalities have shown the existence of facet joint pain. Furthermore, Manchikanti et al (163) established the diagnostic validity of lumbar medial branch blocks on long-term follow-up at 2 years after the initial diagnosis of lumbar facet joint pain in patients with chronic low back pain.

Prevalence

In the 2004 systematic review by Sehgal et al (1), 19 papers provided prevalence estimates for lumbar, thoracic, and cervical facet joint pain (77-84,116-120,126-128,131,132,156). Data on cervical and lumbar facet joint pain have been replicated in multiple studies conducted in academic and private practice settings in Australia and the United States. Tables 4 to 6 (updated in 2006) highlight study characteristics separately for cervical, thoracic, and lumbar facet pain. A number of studies have also evaluated treatment outcomes in subjects undergoing therapeutic procedures after comparative controlled diagnostic blocks and uncontrolled diagnostic blocks (164-174).

Based on the results of these studies, facet joints have been implicated as a source of chronic spinal pain in 15% to 45% of a heterogeneous group of patients with chronic low back pain, 34% to 48% of the patients with thoracic pain, and 36% to 67% of the patients with chronic neck pain.

False-Positive Rates

After careful review, 16 relevant studies evaluating false-positive rates were included for evidence synthesis. All of these studies reported false-positive rates either independently or in conjunction with other parameters. The details are shown in Tables 4-6. These studies implicated single blocks as a source of false-positive results in 27% to 63% of patients in the cervical spine, 42% to 58% of the patients in the thoracic spine, and 17% to 47% in the lumbar spine.

Discussion

The current review is an update of the comprehensive literature search and analysis conducted for a systematic review in 2004 (1). Diagnostic studies were evaluated in accordance with AHRQ (143) and QUADAS (144) criteria as shown in Tables 1 and 2. At least 3 AHRQ and 7 QUADAS criteria were met by each study included in this review.

None of the studies reviewed changed the diagnostic accuracy of facet or zygapophysial joint blocks,

Table 4. *Data of prevalence with controlled diagnostic blocks and false-positive rates in cervical region*

Study	Quality Scoring		# of Subjects	Type	Prevalence	False-Positive Rate
	AHRQ	QUADAS				
Barnsley et al (125) 1993	4/5	13/14	55	RCT	NA	27% (95% CI 15%-38%)
Barnsley et al (83) 1995	4/5	13/14	50	P, DB	54% (95% CI 40%-68%)	NA
Lord et al (84) 1996	4/5	13/14	68	RCT, DB, PC	60% (95% CI 46%-73%)	NA
Manchikanti et al (120) 2002	3/5	10/14	106	P	60% (95% CI 50%-70%)	40% (95% CI 25%-56%)
Manchikanti et al (117) 2002	3/5	10/14	120	P	67% (95% CI 58%-75%)	63% (95% CI 48%-78%)
Manchikanti et al (118) 2004	3/5	11/14	255 of 500 patients	P	55% (95% CI 49%-61%)	63% (95% CI 54%-72%)
Manchukonda et al (131) 2007	3/5	9/14	251 of 500 patients	R	39% (95% CI, 32%-45%)	45% (95% CI, 37% - 52%)
Speldewinde et al (156) 2001	3/5	7/14	97	R	36% (95% CI, 27%-45%)	NA

RCT = randomized, controlled trial; P = prospective; SB = single blind; R = retrospective; PC = placebo controlled; DB = double blind; NA = not available

Table 5. *Data of prevalence with controlled diagnostic blocks and false-positive rates in thoracic region*

Study	Quality Scoring		# of Subjects	Type	Prevalence	False-Positive Rate
	AHRQ	QUADAS				
Manchikanti et al (118) 2004	3/5	11/14	72 of 500 patients	P	42% (95% CI 30%-53%)	55% (95% CI 39%-78%)
Manchikanti et al (119) 2002	3/5	10/14	46	P	48% (95% CI 34%-62%)	58% (95% CI 38%-78%)
Manchukonda et al (131) 2007	3/5	9/14	65 of 500 patients	R	34% (95% CI, 22%-47%)	42% (95% CI, 26%-59%)

P = prospective; R = retrospective

which as reported previously is strong for cervical and lumbar facet joints and moderate for thoracic facet joints.

A recent study revealed that when more stringent criteria (>80% pain reduction) were used, the prevalence of facet joint pain was 39% in the cervical spine, 34% in the thoracic spine and 27% in the lumbar spine (131). Uncontrolled or single medial branch blocks had a false-positive rate of 45% in the cervical and lumbar spine, and 42% in the thoracic spine. These figures are within the previously reported range of 15% to 45% for lumbar spine but lower than the 42% to 48% prevalence rates for thoracic facet pain and 54% to 67% prevalence rates for cervical spine pain. Prevalence of lumbar facet pain in failed back surgery patients was 16% (132).

Table 6. Data of prevalence with controlled diagnostic blocks and false-positive rates in lumbar region

Study	Quality Scoring		# of Subjects	Type	Prevalence	False-Positive Rate
	AHRQ	QUADAS				
Schwarzer et al (77) 1994	4/5	12/14	176	P	15% (95% CI 10%-20%)	NA
Schwarzer et al (129) 1994	4/5	12/14	176	Subjects from previous study	15%	38% (95% CI 30%-46%)
Schwarzer et al (81) 1995	1/4	12/14	63	P, SB	40% (95% CI 27%-53%)	NA
Manchikanti et al (78) 1999	3/5	8/14	120	P	45% (95% CI 36%-54%)	41% (95% CI 29%-53%)
Manchikanti et al (79) 2000	3/5	11/14	200	P	42% (95% CI 35%-49%)	37% (95% CI 28%-46%)
Manchikanti et al (80) 2000	3/5	10/14	180	P	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 (82) 2001	4/5	10/14	120	P	40% (95% CI 31%, 49%)	47% (95% CI 35%, 59%)
Manchikanti et al (126) 2001	3/5	8/14	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 (127) 2001	3/5	7/14	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 (128) 2001	3/5	7/14	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 (117) 2002	3/5	8/14	120	P	40% (95% CI 31%-49%)	30% (95% CI 20%-40%)
Manchikanti et al (116) 2003	4/5	9/14	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 (118) 2004	3/5	11/14	397 of 500 patients	P	31% (95% CI 27%-36%)	27% (95% CI 22%-32%)
Manchukonda et al (131) 2007	3/5	9/14	303 of 500 patients	R	27% (95% CI 22%-33%)	45% (95% CI 36%-53%)
Manchikanti et al (132) 2007	4/5	12/14	Gp I: single surgery = 64 Gp 2: 2 surgeries = 32 Gp 3: 3 or more surgeries = 21 Overall: 117	P	14% (95% CI 5%-23%) 19% (95% CI 5%-33%) 19% (95% CI 2%-36%) Overall: 16% (95% CI 9%-23%)	49% (95% CI 36%-63%) 50% (95% CI 30%-70%) 47% (95% CI 23%-71%) Overall: 49% (95% CI 39%-59%)

P = prospective; SB = single blind; R = retrospective

Two new studies estimated false-positive rates of uncontrolled or single medial branch blocks (131,132). The false-positive rates in these papers were within the range reported in previous studies (17% to 47% in the lumbar spine, 27% to 63% in the cervical spine, and 42% to 58% in the thoracic spine).

The search for a clinical test/criterion to screen out subjects with a low probability of a positive analgesic response to diagnostic facet joint injections continues. More recently Laslett et al (111) revisited this issue and, using complicated statistical analysis, concluded that 7 clinical findings in 4 different combinations (CPR or clinical prediction rules) are highly sensitive in predicting a negative response to a single zygapophysial joint block at 95% pain reduction. Significant limitations of this study include exclusion of 20% subjects (n=31) for various reasons such as failure to complete the study, and potential for selection bias in the absence of a randomized control design. Also it is not known how the authors resolved the issue of false-positives and false-negatives in this study. Two additional studies by the same authors (113,147), one in German (with an abstract in English) reported a proportional chance statistic of 33% and a kappa of 0.31 for diagnostic agreement between clinical diagnoses and diagnoses based on available reference standards for known causes of LBP. Previous studies have attempted to identify reliable clinical predictors of positive or negative response to diagnostic facet injections (87,88,107,108). Clinical studies by others however have failed to confirm the existence of valid clinical criteria for diagnosing facet joint pain (80,91,109). The results shown by Laslett et al (111) need further scientific scrutiny and validation in clinical trials by other researchers. Currently there are no clinical criteria that can predict response to diagnostic facet joint injections.

Schwarzer et al (89,91) had previously reported that imaging abnormalities as seen on CT scanning and bone scintigraphy correlate poorly with the clinical diagnosis of facet joint pain. In contrast to these data, Pneumaticos et al (112) suggest that bone scintigraphy with SPECT scan can identify patients with low back pain requiring facet joint injections. LBP patients randomized to receive facet joint injections based on a positive SPECT scan were compared with those who received facet joint injections as recommended by a referring physician. Thirteen of 15 patients with abnormal SPECT scan reported >1 SD pain score improvement at 1 month in contrast to 7 of 32 patients with a negative scan or no SPECT scan. The authors concluded that use of SPECT scans decreased the number of facet joints injected and resulted in a corresponding cost reduction of $326 per patient. Scrutiny of this study revealed several flaws, the study objective to use SPECT scans to identify LBP patients who would benefit from facet joint injections was not accomplished, because a faulty injection technique was employed. Large volumes of intraarticular plus extraarticular local anesthetic and steroid injections were used. By injecting 3 times the recommended volumes and infiltrating inside and outside the facet joint, the authors performed an injection that cannot be considered a diagnostic injection. Future studies should control for meticulous technique, compare prognostic capability of SPECT scan to a known reference standard (in this case response to comparative control medial branch blocks), evaluate for specificity and sensitivity of the test, analyze data for false-positive and false-negative responses, and perform cost analysis in a randomized double blind fashion.

Use of sedation poses some potential diagnostic and safety issues. Administration of a sedative may slightly increase the likelihood of a false-positive response when compared to a placebo. There are some who recommend against the use of sedation while others believe that sedating patients, where they are relaxed enough to ensure comfort, but sufficiently aware to fully express pain responses, improves safety by preventing jerking movements during needle placement.

Manchikanti et al (150-153) evaluated the confounding influences of sedation on pain ratings in patients undergoing diagnostic facet injections in the lumbar and cervical spine in well designed studies. Although use of IV midazolam and/or fentanyl for conscious sedation may introduce a false-positive response in a small percentage of patients, this effect can be minimized and diagnostic validity of medial branch blocks maintained by using stringent criteria for positive analgesic response. They demonstrated that a small group of subjects display a false-positive response with IV sedation as well as with placebo. Application of >80% pain reduction criterion standard instead of >50% pain reduction decreased the false-positive response from 15% to 10%.

Ultrasound guided injections are used for regional blocks. There is interest in applying this technology in chronic pain. A few papers have described ultrasound guided facet joint and nerve injections in

cadavers and human subjects. Some have attempted face validity studies by confirming needle placement with fluoroscopic or CT imaging. Although there are obvious benefits to using ultrasound guidance, there are insufficient data for critical analysis and conclusions.

The current consensus is that there is no association between the results of facet blocks and clinical findings including imaging studies. Diagnostic facet injection can access deep seated structures not reached by standard spine examination, are able to selectively and accurately target a specified joint or nerve, and have the ability to confirm or exclude a specified joint or structure as the source of pain (124). The results obtained with single blocks should be confirmed by using comparative controlled blocks. Uncontrolled local anesthetic blocks have a limited role in evaluating spinal pain.

Some criticize diagnostic facet injections for lack of a gold standard. A gold or criterion standard allows accurate determination of the specificity and sensitivity of a test and assesses the capacity of a diagnostic test to yield positive results when the clinical condition is present and negative results when the clinical condition is not present (178,179). Tissue confirmation for presence or absence of disease is a commonly accepted criterion standard. There is no tissue diagnosis to confirm the presence or absence of pain. Hence, this reference standard cannot be applied to diagnostic facet joint nerve blocks. An alternative and acceptable reference standard applicable in such situations is abolition or reproduction of the patient's pain symptoms and stability of diagnosis on long-term follow-up (124). Pain provocation is considered to be ineffective in facet joint pain diagnosis (180). Consequently, controlled facet injection techniques are the standard for establishing the diagnosis of facet pain when performed in an accurate, reproducible, and optimal manner. These techniques have been critically analyzed in multiple controlled trials and the results replicated.

Conclusion

Diagnostic facet joint blocks are safe, valid and reliable. Based on review of available studies that met inclusion criteria, the strength of evidence for diagnostic facet injection techniques is unchanged i.e. there is strong evidence that controlled diagnostic blocks distinguish painful from painless facet joints in the diagnostic work up of chronic spinal pain.

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