

A SYSTEMATIC REVIEW

ACCURACY OF PRECISION DIAGNOSTIC BLOCKS IN THE DIAGNOSIS OF CHRONIC SPINAL PAIN OF FACET OR ZYGAPOPHYSIAL JOINT ORIGIN: A SYSTEMATIC REVIEW

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Context: Facet or zygapophysial joint blocks are used extensively in the evaluation of chronic spinal pain. However, there is a continuing debate about the value and validity of facet joint blocks in the diagnosis of chronic spinal pain. The value of diagnostic facet joint injections may have been overlooked in the medical literature.

Objectives: To determine the accuracy of facet joint blocks in the diagnosis of chronic spinal pain of facet joint origin and also determine the rationale, principles, false-positive rate, and diagnostic utility of facet joint blocks as well as prevalence of facet joint pain.

Methods: Relevant literature was identified through searches of MEDLINE, EMBASE (Jan

1966- Mar 2003), manual searches of bibliographies of known primary and review articles, and abstracts from scientific meetings. Studies were selected if they were either placebo-controlled or comparative local anesthetic blocks and met 3 of the 5 criteria established by the Agency for Healthcare Research and Quality.

Information extracted from each study included the details about the study, type, design, patient eligibility criteria, and statistical analysis. Studies were excluded from analysis if they were simply a review or descriptive or involved only a single-block.

Results: The data showed that there was conclusive evidence demonstrating that facet joints have a nerve supply and are ca-

pable of causing pain with provocation in normal volunteers that reproduces typical pain attribution clinically to facet joints. The studies demonstrated a prevalence of facet joint pain in chronic spinal pain patients of 15% to 45% in lumbar spine, up to 48% in thoracic spine, and 54% to 67% in the cervical spine. Single diagnostic blocks showed a false-positive rate of 27% to 63%.

Conclusion: The diagnostic accuracy of controlled local anesthetic facet joint blocks is high in the diagnosis of chronic spinal pain.

Keywords: Spinal pain, facet joints, zygapophysial joints, diagnostic blocks, comparative local anesthetic blocks

Medical literature continues to report that back pain cannot be diagnosed in up to 85% of cases (1-4), despite the fact that there is an extensive literature on the value of diagnostic injection techniques for determining precise causes of low back pain (5-33). The purpose of this review article is to critically evaluate recent evidence regarding the prevalence of back pain attributed to the facet or zygapophysial joints and to evaluate the efficacy of injection techniques in the diagnosis of facet pain. This review may point to clinically useful treatment options and help dispel prevalent nihilistic thinking regarding chronic spinal pain.

Pivotal to the proper management of chronic spinal pain is the ability to pinpoint an anatomical diagnosis. For this purpose, physical examination is neither

reliable nor valid (31). Medical imaging provides little sound information (34). It is often cited that a cause cannot be determined in 85% of patients with low back pain (1-4) or conversely, that a diagnosis is possible in only some 10% to 15% of cases (4, 35, 36). No technique of physical examination has sufficient reliability and validity to allow a patho-anatomic diagnosis to be made (4, 34). Radiographic investigations, including magnetic resonance imaging (MRI), reveal only some conditions with certainty (34).

In the 1990's, new precision diagnostic tests have been developed, evaluated and implemented. Thus, if appropriate tests are used, a diagnosis of chronic spinal pain can be made in at least 50% of the cases, and perhaps in as many as 70% of the cases (5, 6, 8-10, 31, 32). These precision diagnostic techniques include facet or zygapophysial joint blocks, provocative discography, and sacroiliac joint blockade.

Central to the understanding of the structural basis of chronic spinal pain is the provision of a physical diagnosis and validation of patient symptomatology whenever it is feasible rather than discounting emotional involvement. This

concept will remove many of the terms utilized in the past such as "psychogenic," "somatizing," "hysterical," and more recently, "medically unexplained," to explain many of the pain problems not amenable to diagnosis by present methodology utilizing physical examination, radiological and electrodiagnostic testing.

Bogduk (5) postulated that, for any structure to be deemed a cause of back pain:

- The structure should have a nerve supply;
- The structure should be capable of causing pain similar to that seen clinically, ideally demonstrated in normal volunteers;
- The structure should be susceptible to diseases or injuries that are known to be painful; and,
- The structure should have been shown to be a source of pain in patients, using diagnostic techniques of known reliability and validity.

The same philosophy may be applied for thoracic and neck pain. Kuslich et al (37) identified facet joints, ligaments, fascia, muscles, intervertebral discs, and

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nerve root dura as tissues capable of transmitting pain in the low back. Facet joints have been proven to be common sources of pain with proven diagnostic techniques (4-6, 31-33).

Bogduk (6) also postulated that diagnostic blockade of a structure with a nerve supply with the ability to generate pain can be performed to test the hypothesis that the target structure is a source of the patient's pain. Advantages of the needle procedures are that discs and joints of the spine which are not accessible to palpation are accessible to needles introduced onto or into these target structures under fluoroscopic guidance. Compared to palpation, needle procedures have the advantage that they can target a particular structure selectively and accurately. Radiography can be used to confirm that the target structure, and only the target structure, has been reached by the needle or by anything that is injected through it (31). Further, precision diagnostic needle procedures can determine, physiologically, whether or not the target structure is painful. However, imaging studies do not do this. Finally, the major advantage is the critical evaluation of the precision diagnostic blocks as they can be subjected to controls to ensure the validity of the test in each and every patient. Hildebrandt (7) published an extensive review on the relevance of nerve blocks in treating and diagnosing low back pain. Saal (33) has reviewed general principles of diagnostic testing of painful lumbar spine disorders and evaluated diagnostic tests and their inherent limitations.

The popularity of precision diagnostic injections as a diagnostic tool in painful conditions is due to several features. Hogan and Abram (38) described multiple challenging clinical situations, including the characteristics of chronic pain, which are purely subjective and the conditions which are, in most cases, inexactly defined with uncertain pathophysiology. Precision diagnostic blocks are used to clarify these challenging clinical situations, in order to determine the pathophysiology of clinical pain, the site of nociception and the pathway of afferent neural signals. They also reported that clinical studies of precision diagnostic techniques are variable, not only in quality, but also in quantity.

It is of paramount importance to determine the false-positive rate (how often patients without a condition will none-

theless have a positive test), and false-negative rate (how often a patient with disease will have a negative test). The general parameters of accuracy are described as the specificity and sensitivity of the diagnostic test. Specificity is a relative measure of the prevalence of false-positives, whereas sensitivity is the relative prevalence of false-negative results. The most sensitive test will be positive for all cases in which the disease is present. The specificity is greatest when there is a positive test result only when the disease is present. Thus, the ideal diagnostic test would have a sensitivity of 100% and a specificity of 100%. Since none of the tests available in clinical medicine have these ideal features, there is a degree of uncertainty regarding the accuracy of each and every diagnostic test as applied to an individual clinical case.

Hildebrandt (7), in an extensive review on the relevance of diagnostic zygapophysial joint blocks, concluded that the diagnostic use of neural blockade rests on three premises. First, the pathology causing pain is located in an exact peripheral location, and impulses from this site travel via unique and consistent neural route. Second, injection of local anesthetic totally abolishes the sensory function of intended nerves and does not affect other nerves. Third, relief of pain after local anesthetic block is attributable solely to the block of the target afferent neural pathway.

Saal (33) described that the test used to diagnose the source of chronic low back pain requires accurate determination of the abolition or reproduction of the patient's pain symptoms. He compared precision diagnostic injections to the physical examination rather than most laboratory tests used in clinical medicine, which can have an absolute gold standard for comparison to determine their true accuracy because a tissue diagnostic confirmation can be accomplished. He warned that rather than concluding that these tests are useless or invalid, the multiple facts should be considered together with the inaccuracies that are present in all diagnostic tests in medicine.

Bogduk and McGuirk (8-10, 31) described in detail the accuracy and value of precision diagnostic blocks and proposed an algorithmic approach to diagnosis of chronic low back pain, defining the role of precision diagnostic blocks in the diagnosis and treatment of chronic low back pain.

Manchikanti et al (32), 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.

In contrast, Nachemson and Vingård (39), in assessment of patients with neck and back pain, concluded that various studies outside imaging have rarely demonstrated clinical utility. Ramsey et al (40) found that diagnostic and treatment devices lacking in scientific rigor included facet blocks, discography and diagnostic nerve root infiltration, along with other tests including electromyogram, stress radiographs and flexion and extension x-rays, bone scintigraphy, thermography, diagnostic ultrasound, and temporary external fixation. However, these authors failed to take into consideration the criteria of the International Association for the Study of Pain (IASP) (41), as well as the nature of controlled diagnostic blocks. Jaeschke et al (42) stated 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 (43). A gold or criterion standard allows accurate comparison of a given diagnostic test's capacity 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 the presence or absence of a disease at surgery, with a biopsy, or autopsy, which has served as the accepted criterion standard across multiple medical disciplines, is not applicable to interventional pain management. Stability of the diagnosis over a long period of time with long-term follow-up may be also used as a criterion standard.

To demonstrate the validity of facet joint blocks, they must be performed utilizing IASP criteria (41), to avoid false-positives. Thus, face validity and construct validity of facet joint blocks must be maintained. Ideally, all controlled blocks should include placebo injections of normal saline, but it may be neither logistical nor ethical to use placebo injections of normal saline in conventional practice in each and every patient. In addition, one may be required to perform three blocks of the same structure if a placebo is used.

As an alternative, the use of comparative local anesthetic blocks, on two separate occasions, during which the same joint is anesthetized using two local anesthetics with different duration of actions, has been proposed (6, 11-13, 44-46).

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

MATERIALS AND METHODS

Literature Search

The literature search included MEDLINE, EMBASE (Jan 1966-Mar 2003), systematic reviews, narrative reviews, cross-references to the reviews and various published trials; and peer reviewed abstracts from scientific meetings during the past two years. Available literature through March 2003 was utilized. The search strategy consisted of diagnostic interventional techniques, facet joint blocks or zygapophysial joint blocks, with emphasis on chronic pain/low back pain/neck pain/mid back or thoracic pain or spinal pain.

Selection Criteria

The review focused on placebo-controlled and comparative local anesthetic block studies (observational studies) in which the facet or zygapophysial joint blocks were evaluated in a systematic fashion. The population of interest was patients suffering with chronic spinal pain of at least 3 months duration. The diagnostic test was facet joint block and the diagnostic criterion standard was at least 80% pain relief with maneuvers which were painful prior to the diagnostic block.

All the studies providing rationale, principles, validity, prevalence, and comparison to criterion standard were evaluated. The primary outcome measure was the accuracy with which facet joint pain was diagnosed. Secondary outcomes were false-positive rates and complications.

For evaluating the quality of individual articles, we have used the criteria from the Agency for Healthcare Research and Quality (AHRQ) publication (47), which described domains and elements for diagnostic studies (Table 1).

Data Extraction

The algorithm used to evaluate the individual articles, including inclusion and exclusion criteria, is shown in Table 2. Studies that did not meet criteria were eliminated from consideration. Studies were excluded if there were no descriptions of appropriate outcomes or statistical analysis. Thus, for a study to be included, it had to meet at least 3 of the 5 criteria.

RESULTS

Relevant studies meeting the rationale, principles, and validity of facet joint blocks, and studies examining the prevalence of facet joint pain were evaluated. In prevalence estimations, only the studies utilizing controlled comparative local anesthetic blocks or placebo-controlled blocks were utilized. Studies confirming the criterion standard were also evaluated.

Facet or zygapophysial joint block is a diagnostic procedure designed to determine whether a facet joint is responsible for patient's pain. It includes proper placement of the needle, injection of local anesthetic, and assessment of patient's pain response. Facet joint blocks have

been used extensively in the study of lumbar facet joints, somewhat less so in the study of cervical facet joints, and infrequently in the study of thoracic facet joint pain. Even though, originally introduced as a technique prior to fusion and a therapeutic technique, facet joint blocks are no longer utilized prior to fusion. They are most commonly utilized for diagnostic purposes to establish a diagnosis of facet or zygapophysial joint pain and to offer therapeutic options.

Rationale

The facet joints are well innervated by the medial branches of the dorsal rami (48-54). In the cervical spine below C2/3, the cervical facet joints are supplied by medial branches of the cervical dorsal rami above and below the joint, which also innervate the deep parameidial muscles. The C2/3 joint is supplied by the third occipital nerve (48, 55). In the thoracic and lumbar spine, the facet joints are innervated by medial branches of the dorsal rami of the spinal nerves except at L5 level. The L5 dorsal ramus divides into medial and lateral branches, with the medial branch continuing medially, innervating the lumbosacral joint (56, 57, 59). Each segmental medial branch of the dorsal ramus supplies at least 2 (in humans, monkeys, and cats) or 3 (in rats) facet joints (50).

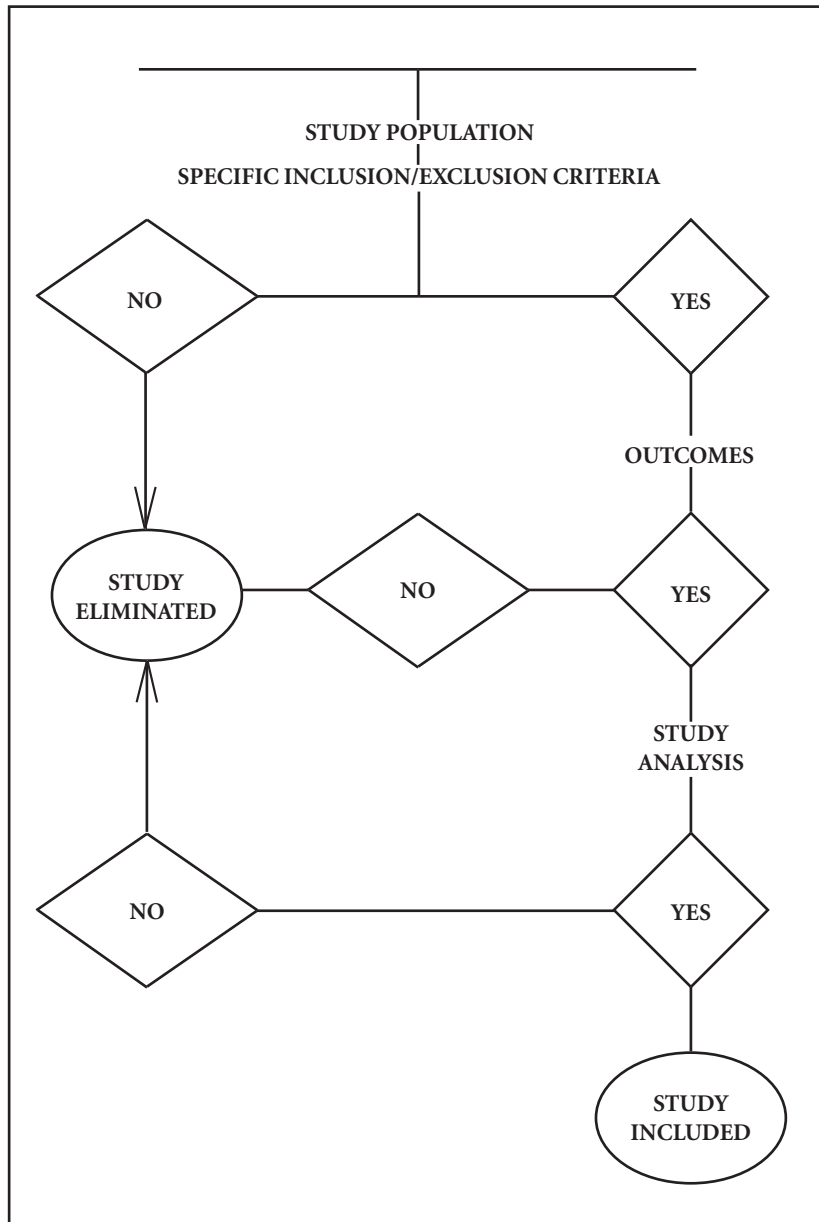
Cervical facet joints have been shown to be capable of being a source of neck pain and referred pain in the head or upper limb girdle; thoracic facet joints have been shown to be capable of being a source of thoracic pain and referred pain over the chest wall; and lumbar facet joints have been shown to be capable of being a source of low back pain and re-

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

Domain	Elements*
Study Population	<ul style="list-style-type: none"> <i>Subjects similar to populations in which the test would be used and with a similar spectrum of disease</i>
Adequate Description of Test	<ul style="list-style-type: none"> <i>Details of test and its administration sufficient to allow for replication of study</i>
Appropriate Reference Standard	<ul style="list-style-type: none"> <i>Appropriate reference standard ("gold standard") used for comparison</i> Reference standard reproducible
Blinded Comparison of Test and Reference	<ul style="list-style-type: none"> Evaluation of test without knowledge of disease status, if possible <i>Independent, blind interpretation of test and reference</i>
Avoidance of Verification Bias	<ul style="list-style-type: none"> <i>Decision to perform reference standard not dependent on results of test under study</i>

*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.

Table 2. Study evaluation (inclusion/exclusion) algorithm



ferred pain in the lower limb in normal volunteers (60-70). There are no reliable clinical or radiological means of implicating zygapophysial or facet joints as the source of spinal pain in a given patient (4, 6, 8, 11, 14-32, 34, 60-86).

Principles

Blocks of a facet or zygapophysial joint can be performed in order to test the hypothesis that the target joint is the source of the patient's pain (2, 6-10, 31-34, 57-59). Facet joints can be anesthetized either with intraarticular injections

of local anesthetic or by anesthetizing the medial branches of the dorsal rami that innervate the target joint. If pain is not relieved, the joint cannot be considered the source of pain, whereupon a new hypothesis about the source of pain is required (6). The source may be either in another joint or some other structure. If pain is relieved, the joint may be considered *prima facie* to be the source of pain, but steps need to be taken to ensure that the observed response is not false-positive (6). True-positive responses are

secured by performing controlled blocks, either in the form of placebo injections of normal saline or comparative local anesthetic blocks, in which on two separate occasions, the same joint is anesthetized but using local anesthetics with different durations of action. Comparative local anesthetic blocks are readily implemented if medial branch blocks are used to anesthetize zygapophysial joints. They may not be implementable for intraarticular blocks, for it is not known whether placement of local anesthetic in a relatively avascular environment, such as a joint space, affects its expected duration of action. Further, an injected capsule may leak into the adjacent neural foramen and result in blockade of the dorsal root ganglion and segmental nerves (87-90).

Medial branch blocks are performed under fluoroscopic control. They involve introducing onto each of the two nerves that innervate the target joint. Each nerve can be anesthetized by injecting as little as 0.3 mL of local anesthetic. The average local anesthetic solution injected is approximately 0.5 mL.

Validity

Medial branch blocks have been shown to have 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 (57, 58). In addition, medial branch blocks have been shown to protect normal volunteers from pain provoked experimentally from the anesthetized joint (31, 59).

Medial branch blocks also have shown to have construct validity. However, to have construct validity, medial branch blocks must be controlled. Single diagnostic blocks carry a false-positive rate of 27% to 63% in cervical spine, 58% in the thoracic spine, and 22% to 47% in lumbar spine (15-22, 27-30). Patients are liable to report relief of pain after a diagnostic block for reasons other than the pharmacologic action of drug administered (13). Thus, it is essential to know in every individual case whether the response is a true positive. The validity of controlled comparative local anesthetic blocks for facet joint diagnostic blocks was confirmed with placebo-controlled diagnostic blocks (12, 13).

False-positive rate of diagnostic facet joint blocks evaluated in two groups of patients, either with diagnosis of somatization disorder or without such a diagnosis (91). 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 adjuvants was also evaluated (17). Based on this evaluation, there was no difference noted in the capacity to diagnose facet joint pain with local anesthetics administered alone or with mixtures of Sarapin or Sarapin and methylprednisolone.

Criterion Standard

No results of biopsy or autopsy were available to confirm specificity and sensitivity of medial branch blocks. However, other criterion standards accepted across multiple medical disciplines include pain relief (12-30, 91) and stability of the diagnosis over a long period of time with long-term follow up (92-99).

Prevalence

Multiple publications were examined to evaluate the diagnostic validity of facet joint blocks. Of these, only prospective evaluations that were performed under fluoroscopic guidance, with low volume injectate (less than 1 mL) were examined, and only studies using placebo-controlled or comparative local anesthetic blocks were included. A total of 17 studies were evaluated for validity, prevalence, and false-positive rate (14-30). Based on these evaluations, facet or zygapophysial joints have been implicated as a source of chronic spinal pain in 15% to 45% of the heterogeneous groups of patients with chronic low back pain (14-17, 25-27), 48% of the patients with thoracic pain (20), and 54% to 67% of the patients with chronic neck pain (18, 19, 23, 24). The prevalence of facet joint pain in the elderly, post lumbar laminectomy patients and in obese patients (28-30) were also evaluated showing significantly higher prevalence in elderly and non-surgical patients (28, 29). There were no differences noted in obese patients (30).

Diagnostic Utility

Establishing a diagnosis of facet or zygapophysial joint pain provides a valid diagnosis and also therapeutic options. It also obviates the need for any further investigations in the pursuit of a diagnosis. Prevalence of facet or zygapophysial joint pain provides significant pre-test and post-test probabilities. Successful management of facet joint pain has been reported with interventional techniques (92-99).

Strength of Evidence

Based on the review of all the available studies meeting our inclusion criteria, there is conclusive evidence that facet joints are innervated, are capable of causing pain similar to that seen clinically, and are a source of pain in patients, with chronic spinal pain, and there is strong evidence that controlled diagnostic facet joint blocks to establish diagnosis of facet joint pain in chronic spinal pain.

Complications

There were no complications reported with diagnostic facet or zygapophysial joint blocks performed under fluoroscopy with low volume local anesthetic injection with or without adjuvants.

DISCUSSION

Our review shows that diagnostic facet (zygapophysial) joint blocks are safe, valid, and reliable, with a significant and variable false-positive rate. When performed under fluoroscopic visualization utilizing IASP (41) criteria, 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 to conclusive. In contrast, facet joint pain cannot be diagnosed or excluded with high level of certainty without precision diagnostic interventional techniques.

The strength of our review is based on its compliance with criteria for evaluating diagnostic tests as established by AHRQ (47). These were described as important domains and elements for diagnostic studies, which included: study population, adequate description of

the test, appropriate reference standard, blinded comparison of test, and reference and avoidance of verification bias. Overall, this review met the criteria described by Bogduk (5) with nerve supply, production of pain similar to that seen clinically in normal volunteers, facet joints as a source of pain in patients using precision diagnostic facet or zygapophysial joint blocks, unreliability of provocation, and a significant false-positive rate with single blocks.

The inability of a physician to provide appropriate and accurate diagnosis for a patient with chronic spinal pain is frustrating for the patient and the doctor. Although the history and physical examination alone are not diagnostic in a majority of patients with chronic spinal pain, they provide appropriate understanding of the nature of the problem and are important tools in screening for neurological problems and other red flag indicators. Psychological assessment may assist in identification of patients with psychiatric and behavioral problems. Radiological investigation may identify anatomic problems, such as disc herniation, high-intensity zone lesions, and vertebral endplate changes which indicate the presence of disc-related pain (34). However, imaging studies can not discern whether a particular anatomic finding hurts. However, precision diagnostic interventional techniques can identify a painful lesion, and are of paramount importance in formulation of an anatomic diagnosis.

One of the major criticisms of our findings is that none of the studies were validated with "criterion standard" tests, such as autopsy, surgical findings, or biopsy. However, our review confirms the validity of facet joint blocks as a reliable diagnostic tool, comparing not only immediate pain relief with maneuvers which were previously painful, but on the basis of a predictable and demonstrable false-positive rate, and the potential for providing therapeutic benefits on a long-term basis.

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