Precision Diagnosis of Spinal Pain

Nikolai Bogduk, MD, PhD, FAFRM
Faculty of Medicine, University of Newcastle, Newcastle, Australia
Cervical Spine Research Unit, Mater Misericordiae Hospital, Newcastle, Australia

Richard Derby, MD
Spine Care, San Francisco, California, USA

Charles Aprill, MD
Magnolia Diagnostics, New Orleans, Louisiana, USA

Susan Lord, BMed, PhD
Faculty of Medicine, University of Newcastle, Newcastle, Australia
Cervical Spine Research Unit, Mater Misericordiae Hospital, Newcastle, Australia

Anthony Schwarzer MB BS, PhD, FRACP
Faculty of Medicine, University of Newcastle, Newcastle, Australia

EDUCATIONAL OBJECTIVES

The general objective of the course is to replace pattern recognition and habit with an evidence-based, problem-solving approach for the investigation and management of spinal pain. Specifically, participants will gain an understanding of

1. the anatomical basis of spinal pain
2. the spectrum of lesions or disorders that commonly underlie spinal pain
3. the procedures available for pinpointing sources of spinal pain
4. the validity of these diagnostic procedures
5. the epidemiology of various common disorders
6. the therapeutic utility of precision diagnosis
7. the merits of a structural organic approach to spinal pain compared to the classical biopsychosocial model of spinal pain.

INTRODUCTION

Spinal pain may be localized or it may be associated with somatic referred pain. It can be described in terms of the anatomical regions in which it is perceived (Merskey and Bogduk 1994). The most common forms of spinal pain are lumbar spinal pain (back pain), cervical spinal pain (neck pain), headaches which are due to referred pain from the neck, and sacral spinal pain. Although there are other regional spinal pain problems, it is these that have been most fully and reliably explored. Similarly, although procedures have been developed for the investigation of thoracic spinal pain (Chua and Bogduk 1995; Dreyfuss et al. 1994a; Schellhas et al. 1994) and the upper cervical synovial joints (Dreyfuss et al. 1994b) their validity and utility have not been determined; nor has the epidemiology of the conditions they purportedly diagnose.

It is quite clear from clinical experience and from formal studies that when a patient presents with spinal pain, there are no clinical features that permit the source of pain to be diagnosed (Barnsley et al. 1995; Schwarzer et al. 1994a,b, 1995a,b). Even imaging studies do not provide a diagnosis. So-called “red flag” conditions are indicated by elements of history, including the patient’s age, past history, and general medical health. Tumors, infections, systemic diseases, inflammatory disorders and visceral diseases can and should be overtly suspected on the basis of history, clinical examination and serology, and do not require imaging as screening tests (Bogduk 1995; Deyo and Diehl 1986).

Once medical conditions have been excluded, imaging studies and EMG are immaterial for determining a diagnosis. The habit has been to rely on EMG and CT or MRI to detect disc herniation, but this condition presents with leg pain and objective neurological signs. It is illogical and wasteful to order investigations designed to detect disc herniation when there are no grounds clinically for suspecting this condition; and more patently so when disc herniation is obviously not the cause of pain.

For a patient with spinal pain without neurological signs, the question is: From where does the pain stem; what is its source? EMG, CT, and MRI do not answer this
The innervation of the sacroiliac joints is still in question. The appropriate investigations are ones that do answer this question.

ANATOMICAL BASIS

For a structure to be a source of pain it must have a nerve supply. In the neck and in the lumbar spine, the dorsal rami of the spinal nerves supply the zygapophysial joints and the posterior spinal muscles (Bogduk 1982; Bogduk et al. 1982). The intervertebral discs are supplied by anterior and posterior longitudinal plexuses fed by the sympathetic trunks and sinuvertebral nerves (Bogduk et al. 1981; Bogduk et al. 1988; Green et al. 1990; Mendel et al. 1992). The innervation of the sacroiliac joints is still in dispute; it is not clear whether these joints are supplied from the front by branches of the lumbosacral ventral rami and from the back by sacral dorsal rami or solely from the back (Grobg 1995).

The zygapophysial joints, the intervertebral discs and the sacroiliac joints are the cardinal candidates for sources of chronic spinal pain, and it is these structures that have attracted the greatest deal of scientific attention in recent years. Although suspected and proclaimed as sources of pain, the spinal muscles and spinal dura have not attracted the same degree of scientific scrutiny. They remain possible sources of pain (Bogduk 1992) but for lack of evidence they are not considered further in this course.

SOURCES OF SPINAL PAIN

It is quite clear from experiments in normal volunteers that spinal pain and referred pain can be produced by stimulating the lumbar zygapophysial joints (McCall et al. 1979; Mooney and Robertson 1976), the cervical zygapophysial joints (Aprill et al. 1990; Dwyer et al. 1990) and the sacroiliac joints (Fortin et al. 1994). Normal intervertebral discs do not hurt in asymptomatic volunteers but are clearly sensitive to provocation in certain patients with spinal pain (Bogduk 1994a; Bogduk et al. 1995a).

Although the zygapophysial joints can be a source of spinal pain, there is no singular nor common lesion that renders them painful and which can be detected by imaging. Lesions such as small fractures, meniscal tears and hemarthroses have been detected in post-mortem studies, and have been shown to be invisible in plain radiographs (Jonsson et al. 1991; Taylor et al. 1990; Twomey et al. 1989); but it has still to be determined if such lesions underlie back pain and neck pain stemming from the zygapophysial joints.

Neither in the neck nor in the back does osteoarthritis seen on X-ray correlate with the presence of pain (Friedenberg and Miller 1963; Magora and Schwartz 1976; Lawrence et al. 1966); nor do CI features correlate with proven lumbar zygapophysial joint pain (Schwarzer et al. 1995d). Consequently, in the pursuit of zygapophysial joint pain all that can be done to test if a suspected joint is the source pain is to anaesthetize that joint. Similarly, there are no demonstrable lesions that identify a painful sacroiliac joint. Like the zygapophysial joints that joint must be anaesthetized to show if it is painful or not.

Intervertebral discs are difficult to anaesthetize. Intradiscal injections of local anesthetic may succeed in relieving a patient's pain, but such injections are liable to false-negative results if the injected agent fails adequately to infiltrate the nerve endings in the outer annulus fibrosus that mediate the patient's pain. Consequently, the best available criterion standard for discogenic pain is disc stimulation, in which a needle is used to distend the disc in the course of discography, in an effort to reproduce the patient's pain.

Although no radiologically detectable lesions have been found to affect the synovial joints of the spine, this is not the case for painful lumbar discs. The studies of Vanharanta et al. (1987), subsequently reappraised by Moneta et al. (1994), show a clear and statistically significant correlation between disc pain and grade 3 fissures of the annulus fibrosus (Table 1) (Fig. 1). Moreover, logistic regression has shown that annular fissures alone correlate with disc pain; disc degeneration expressly does not (Moneta et al. 1994).

Table 1. The correlation between annular disruption and reproduction of pain by disc stimulation.

<table>
<thead>
<tr>
<th>Pain Reproduction</th>
<th>Anular Disruption</th>
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<tr>
<td></td>
<td>GDE 3</td>
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<tr>
<td>Exact</td>
<td>43</td>
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<tr>
<td>Similar</td>
<td>32</td>
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<tr>
<td>Dissimilar</td>
<td>9</td>
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<tr>
<td>None</td>
<td>16</td>
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Based on Moneta et al. 1994.

\[ X^2 = 148; p < 0.001. \]

Anular fissures are the characteristic feature of internal disc disruption (IDD), an entity rendered evident by CT discography, and most likely traumatic in origin (Bogduk 1991; Bogduk et al. 1995a). In some cases, painful fissures are evident on MRI (Aprill and Bogduk 1992) (Fig. 2), but disc provocation is nonetheless required to prove conclusively that the apparently affected disc is, indeed, painful.

PROCEDURES

The zygapophysial joints of the neck and back can be anaesthetized under image-intensifier guidance by injections of local anesthetic either into the target joint or onto the medial branches of the dorsal rami that supply them (Bogduk et al. 1995b,c) (Figs. 3 and 4). The sacroiliac joint can be anaesthetized by intra-articular injection of local anesthetic (Bogduk et al. 1995b; Schwarzer et al. 1995b) (Fig. 5).
Cervical and lumbar discs can be stimulated by needles inserted into the nucleus of these discs (Fig. 6). Contrast medium or normal saline can be injected carefully to distend the disc in an effort to reproduce the patient’s pain (Bogduk et al. 1995a).

All of these procedures require skill, care and good facilities in order to avoid possible complications (Bogduk et al. 1995a,b). Patients must be carefully briefed and informed in order to obtain reliable information; procedures performed roughly or without precision compromise the quality of information obtained and its reliability.

VALIDITY

SYNOVIAL JOINT BLOCKS

Placebo responses are the greatest threat to the validity of synovial joint blocks. Formal studies have shown that some 30% of patients ostensibly undergoing lumbar zygapophysial joint blocks can report complete relief of their back pain following simply a subcutaneous injection of normal saline (Schwarzer et al. 1995a). Furthermore, single diagnostic blocks are unreliable. They are associated with a false-positive rate of 32% in the lumbar spine (Schwarzer et al. 1994c) and 28% in the cervical spine (Barnsley et al. 1993a); patients who respond to an initial block will not necessarily respond to a confirmatory block.

For diagnostic blocks to be valid they must be controlled in each and every patient. Without controls, two out of every three apparently positive lumbar zygapophysial joints will be false-positive (Schwarzer et al. 1994c). Failure to implement such controls invalidates all of the previous literature on these blocks (Bogduk et al. 1995b,c). Controlled diagnostic blocks must become the standard of care lest the use of these blocks continue to be invalid.

Two forms of control are available: saline and comparative local anesthetic blocks. Saline controls under double-blind conditions are rigorous but impractical. They require at least three procedures. The first must be performed using a local anesthetic in order to identify a putatively painful joint. (There is no sense in blocking a joint saline when it might not even be painful.) The second block cannot routinely be normal saline for would-be mischievous patients would know that the second block would
always be the dummy. To maintain chance, a second and a third block must be implemented each randomly determined to be either a local anesthetic or saline. Because of the logistics involved in performing triple blocks their use is likely to remain restricted to research units or fastidious spine centers.

Comparative local anesthetic blocks conveniently circumvent the logistic problems and ethical problems of using saline controls. Their underlying principle is that genuine patients can be identified if on separate occasions they obtain long-lasting relief when a long-acting agent is used and short-lasting relief when a short-acting agent is used. The construct validity of this paradigm has been formally established (Barnsley et al. 1993b). Moreover, the paradigm has been tested against placebo and found to be robust (Lord et al. 1995a).

However, comparative blocks are not totally reliable. On the one hand, some 15% of patients who satisfy the criteria for a positive response also respond to placebo (Lord et al. 1995a). Thus, comparative blocks are only 85% reliable. On the other hand, some patients exhibit enigmatic responses to comparative blocks, e.g. prolonged response to lignocaine, and would fail to be called positive responders. However, 65% of such patients withstand challenge with placebo (Lord et al. 1995a). Their enigmatic responses are not placebo responses, and probably reflect the affect of local anesthetics on dynamic, as opposed to closed, sodium channels (Butterworth and Strichartz 1990).

Clinicians, therefore, need to be fluid with respect to the criteria for positive responses to comparative blocks. Calling positive all patients who respond to both blocks irrespective of duration of response increases the sensitivity but lowers the specificity of the blocks. Retaining strict criteria of differentiating long-acting and short-acting agents, increases the specificity but at the cost of sensitivity (Lord et al. 1995a).
Fig. 4. An oblique radiograph of the lumbar spine showing a needle in position for the execution of an L3 medial branch block. Contrast medium shows how focal the deposition is of the injectate.

Fig. 5. An antero-posterior radiograph of a sacroiliac arthrogram.
applied, liberal criteria for comparative blocks can be tolerated; but if neurodestructive procedures are to be undertaken, stricter criteria or even saline controls should be applied (Lord et al. 1995a). However, without some form of control both the diagnostic process and the subsequent therapeutic endeavors will be corrupted, to the cost of the patient and to the cost of the health care system.

DISC STIMULATION

Formal studies in normal volunteers have shown that lumbar disc stimulation is a highly specific test; lumbar discs do not hurt in asymptomatic individuals (Walsh et al. 1990). Thus, finding a painful disc in a patient is a significant observation. However, even so, controls are mandatory to exclude false-positive responses, i.e., to refute the competing hypothesis that stimulating any disc reproduces the patient's pain.

The IASP has recommended that for disc stimulation to be considered valid, at least one and preferably two adjacent discs be stimulated as controls. For a disc to be deemed painful stimulation of that disc but neither of the adjacent discs should reproduce the patient's pain (Merskey and Bogduk 1994). For IDD to be diagnosed not
only must the patient satisfy the criteria for discogenic pain but also a grade three fissure must be demonstrated on post discography CT (Merskey and Bogduk 1994). Unless these criteria are satisfied, grave doubts can be cast on the diagnosis offered.

With respect to cervical discogenic pain, investigators must be cautious. Cervical disc stimulation is not supported by literature as robust as that pertaining to the lumbar spine (Bogduk et al. 1995a). The cervical discs are not subject to the same lesions as are lumbar discs, and it is not convincingly clear that cervical discs do not hurt in normal volunteers. Moreover, it has been shown that patients with apparently painful discs can have their pain relieved by blocks of the zygapophysial joints at the same segment (Bogduk and Aprill 1993), and that in patients with cervical myelopathy but no neck pain, disc stimulation is painful in some 50% (Shinomiya et al. 1993).

**EPIDEMIOLOGY**

In the past, belief in zygapophysial joint pain, sacroiliac joint pain and discogenic pain has been based on fashion, passion and defiance. These entities have been controversial. Recent studies, however, have brought science to bear.

Using placebo-controlled blocks, the prevalence of lumbar zygapophysial joint pain in a sample of Australian, Rheumatology patients with chronic low back pain was found to be 40% with 95% confidence intervals (CI) of 27%-53% (Schwarzer et al. 1995a). Using comparative blocks in a sample of American patients with back pain, the prevalence of zygapophysial joint pain was found to be 15% (95% CI: 10%-20%) (Schwarzer et al. 1994a).

Using comparative local anesthetic blocks, the prevalence of cervical zygapophysial joint pain was found to be 54% in patients with chronic neck pain after whiplash (Barnsley et al. 1995), and this figure has now been confirmed using saline controlled, triple diagnostic blocks (Lord et al. 1996a). Moreover, headache after whiplash can be traced in the majority of patients to a painful C-3 zygapophysial joint (Lord et al. 1994).

Using intra-articular blocks, the prevalence of sacroiliac joint pain was found to be 13% in patients with chronic low back pain (95% CI: 6%-20%) (Schwarzer et al. 1995b). This figure will soon be substantiated by a study yet to be published, that employed comparative local anesthetic blocks.

The prevalence of cervical discogenic pain has not been formally studied, but that of lumbar discogenic pain has. Using the stringent criteria of the IASP, the prevalence of IDD amongst patients with chronic low back pain has been found to be 39% (95% CI: 29%-49%) (Schwarzer et al. 1995c).

With respect to back pain, it has furthermore been shown that zygapophysial joint pain, IDD and sacroiliac joint pain rarely coexist in the same patient (Schwarzer et al. 1994d). Less than 10% of patients have more than one condition; the majority suffer either IDD, zygapophysial joint pain or sacroiliac joint pain, with IDD being the most common entity, accounting for 39% of patients.

These prevalence figures cannot be ignored; they are based on controlled studies. Contrary to conventional wisdom that 70% of low back pain cannot be diagnosed, the converse is true. With 39% suffering IDD; 15% suffering zygapophysial joint pain and 12% suffering sacroiliac joint pain, a source of pain can be found in over 60% of patients. Other entities such as dural irritation (Bogduk and Twomey 1991) and torsion injuries to the disc (Bogduk 1991; Bogduk et al. 1995a) have not been formally studied but could account for a good proportion of the remainder.

These prevalence figures put beyond doubt that patients with chronic low back pain indeed do suffer from identifiable, organic sources of pain. The nihilism and defeatism commonly applied to low back pain stems from the failure of most practitioners to implement investigations that answer the question from where does the pain stem. If inappropriate tests such as EMG and imaging are used nothing will be found in the majority of cases, falsely justifying the impression that nothing can be found, and that therefore the problem must be a complex biopsychosocial one. However, this is not the impression that arises if and once procedures designed for precision diagnosis are implemented.

In the case of neck pain, zygapophysial joint pain has been shown to be the single most common source of chronic pain; yet abjectly this is singularly the most overlooked diagnosis. The reason would appear to be that physicians are not taught about this diagnosis. Not taught to consider it, they don’t; and the 50% of patients who have it are denied a diagnosis and at best are told they have a biopsychosocial problem, or at worst are accused of malingering or fraud.

A further reason, and one that pertains to all precision spinal diagnostic procedures is that they require special facilities and special skills; they are not office procedures. To date, they have been restricted to specialized radiology or spine centers, and have not been embraced by leading pain clinics that direct political correctness in this field. However, this ideological difference does not refute the scientific propriety of precision procedures that are executed responsibly under controlled conditions.

**UTILITY**

The ultimate measure of any diagnostic procedure is its therapeutic utility. At the end of the day, does pinpointing a diagnosis make any difference to management; if a source of pain is found, is there a specific treatment that can completely stop that pain?

For some of the entities addressed above there are specific treatments; for others, such treatments are still being developed. To expect a treatment for every condition is somewhat unfair and demanding, for the scientific evi-
idence of the prevalence of these conditions has not been available for more than two years in most instances.

Sacroiliac joint pain is an example of a condition that can be diagnosed but for which there is no established treatment. Conservative measures have not proved effective, and operative treatments have no decent reputation. This is clearly a condition that currently rests on the drawing board.

The only treatment for IDD that makes any sense anatomically and biomechanically is anterior lumbar interbody fusion. Posterior and lateral fusions are not appropriate because the offending disc remains in situ and continues to generate chemical and mechanical nociception (Bogduk 1991); persistent discogenic pain has been demonstrated in patients who have undergone technically satisfactory posterolateral fusions (Weatherley et al. 1986).

In this regard reviews of the literature paint a poor picture of fusion (Turner et al. 1992) but that is because, in the past, surgeons have applied a variety of fusions indiscriminately to patients, without formulating a precision diagnosis, using persistent back pain as the sole indication for operation. In contrast, some surgeons testify to good results with anterior lumbar interbody fusion if the procedure is restricted to patients with morphologically abnormal discs on MRI which prove to be painful upon disc stimulation (Gill -and Blumenthal 1992; Newman and Gristead 1992). Such anecdotes, however, do not complement the science that has been applied to the diagnosis of IDD. What is critically and urgently required are formal studies that document the success of fusion and the correlation between success, failure and the response to diagnostic disc stimulation. The same applies to cervical discogenic pain, where the enthusiasm for fusion has not been matched by scientific diagnostic studies. Such studies are currently being fostered by the International Spinal Injection Society (Bogduk 1994b; Derby 1994).

An exciting alternative is intra-discal injection of steroids. In a preliminary audit, it has been found that the majority of patients with a painful disc that exhibits a high-intensity zone in its anulus on MRI, steroids offer good relief of pain to the extent of avoiding planned surgery (Schellhas et al. 1995). It is imperative, however, that this observation urgently be subjected to a controlled trial before it is adopted and abused as a false panacea for IDD.

Notwithstanding the optimism that finding a painful disc may lead to effective therapy, disc stimulation as a diagnostic test has just as important a negative value. If disc stimulation fails to reproduce a patient’s pain, a diagnosis of discogenic pain cannot be rendered. Such a negative diagnosis has the power to advise against, if not prevent, gratuitous disc surgery being inappropriately applied. Thus, disc stimulation has the power to protect patients from unnecessary surgery as much as, if not more than, committing them to surgery.

With respect to lumbar zygapophysial joint pain, intra-articular injection therapy has been shown to offer no lasting benefit; steroids offer no advantage over saline (Carette et al. 1991). The only other specific therapy that has been touted is percutaneous radiofrequency (RF) neurotomy. This procedure has a checkered past, largely because it was fostered by enthusiasm but no scientific accountability (Bogduk et al. 1995a). In particular, few proponents ever used anatomically accurate techniques (Bogduk et al. 1987) Recent studies, however, have shown a clear relationship between positive response to blocks and good outcome after treatment; the treatment does not work in patients who do not respond to blocks (North et al. 1994). This underscores the critical relationship between precision diagnosis and targeted therapy. However, in the case of lumbar RF neurotomy, controlled studies have not yet properly vindicated the utility of the procedure. This is not the case for cervical neurotomy.

Intra-articular steroids have been shown to offer no worthwhile therapeutic benefit for cervical zygapophysial joint pain (Barnsley et al. 1994), but RF neurotomy does. An open audit of cervical RF neurotomy showed that treatment of pain from the C2-3 zygapophysial joint was marred by technical problems, but results at levels below C2-3 were sufficiently impressive to justify a controlled trial (Lord et al. 1995b). This study has now been completed (Lord et al. 1996b).

Patients were enrolled in the study if they obtained complete relief of their neck pain following blocks of the painful joint on two occasions with local anesthetics but provided they did not obtain relief when challenged with placebo. All patients underwent a radiofrequency neurotomy procedure lasting three hours. The procedure was identical in all respects save that half of the patients received lesions at 80° C while half received the same electrode placements but no current was delivered. Neither the patient nor the surgeon knew what was delivered.

Survival analysis revealed that those patients who received sham lesions had a median duration of relief of 11 days. The median duration of relief in those who received active treatment was 227 days at the time of follow-up, with several patients still continuing with complete relief of pain.

Cervical RF neurotomy is not a placebo procedure. It affords complete relief of pain stemming from cervical zygapophysial joints. In those patients in whom zygapophysial joint pain has been diagnosed by triple, saline controlled, diagnostic blocks.

So complete is this relief that patients score zero or not more than 5/100 on a visual analog scale; their total word score is zero on the McGill Pain Questionnaire; and they resume normal activities of daily living. However, even more striking is that their profiles of psychological distress, as measured by the SCL-90R, revert to normal across all scales (Wallis et al. 1996).

DISCUSSION

Proper studies of the treatment of spinal pain are still in their infancy. The few investigators committed to this
field in recent years have been pre-occupied with the validation of precision diagnostic techniques; resources have not been available to pursue studies of therapy. However, the history and evolution of cervical zygapophysial joint pain illustrates what can be achieved, and underscores the philosophy of proponents of spinal injection procedures.

Originally, cervical zygapophysial joint pain was only a strange belief not credited by Medicine at large (Bogduk and Aprill 1992), and indeed, formally questioned (Frymoyer 1989). However, precision diagnostic techniques were developed and shown to have face validity (Barnsley and Bogduk 1993) and construct validity (Barnsley et al. 1993b), and to be robust against placebo (Lord et al. 1995a). Far from being strange, this condition was shown to be very common (Barnsley et al. 1995) even under placebo controlled conditions (Lord et al. 1996a). A specific therapeutic technique was developed and audited (Lord et al. 1995b) and survived a placebo-controlled trial (Lord et al. 1996b).

The sequence of systematic studies demonstrates that a symptom (neck pain), previously considered intractable and beyond diagnosis, can be resolved using a reductionist approach. The medical model so much maligned in pain circles, can be successful. Pin-pointing a source of spinal pain using precision techniques allows therapy to be specifically targeted and implemented. Moreover, once pain is completely relieved psyche-social elements of the original problem melt away.

This has not been the experience with other procedures and other therapies. However, that is because it has been the fashion to implement new diagnostic procedures and new therapies without scientific rigor. The responsibility now lies with proponents of precision diagnostic techniques to do for disc stimulation, sacroiliac blocks, lumbar zygapophysial joint blocks, and other spinal blocks, what has been achieved for cervical zygapophysial joint pain—a full cycle of validated diagnostic techniques, epidemiological studies and proven, targeted therapy. For lumbar zygapophysial joint pain and IDD, most of this cycle is complete. The techniques are available; the epidemiological studies have been done; the final step is the link to good therapy.

The glaring feature of precision diagnosis of spinal pain is that it is politically incorrect. The management of spinal pain is currently attended by defeatism and nihilism. It seems to have been accepted that 70% of spinal pain cannot be diagnosed; yet the converse is true.

Precision diagnostic procedures legitimately answer the crucial question: From where does the pain come? They do not rely on pattern recognition. Instead, investigators follow this algorithm:

1. the patient complains of pain.
2. from where could this pain arise?
3. in the neck the pre-test probability of zygapophysial joint pain is 50%; therefore, test for zygapophysial joint pain.
4. in the back, the pre-test probability of lumbar zygapophysial joint pain is 15% to 40%; therefore, test for lumbar zygapophysial joint pain.
5. the pre-test probability of sacroiliac joint pain is 12%; therefore, if zygapophysial joint blocks are negative, test for sacroiliac joint pain.
6. the pre-test probability of lumbar IDD is 39%; therefore, if synovial joint blocks are negative, test for IDD.

Such an algorithm clarifies 50% of neck pain, and 60% of back pain—a substantial improvement on minus 70%.

Critics of precision spinal diagnosis should re-appraise their stance in view of the literature presented here. Opposition should not be based on the poor reputation of these procedures because they were performed indiscriminately in the past or without controls; that should no longer be an acceptable standard of we. Nor should opposition arise because the required techniques are not available in one’s local clinical environment. If physicians wish to make precision diagnoses they should engineer to have appropriate techniques made available. Not to do so means that the benefits of scientific progress in this field are being denied to patients for cultural and political reasons.

REFERENCES


Correspondence to: Professor N. Bogduk, Faculty of Medicine and Health Sciences, University of Newcastle, University Dr, Callaghan, NSW 2308, Australia. Tel: 61-49-215608; Fax: 61-49-216903.