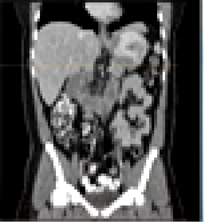

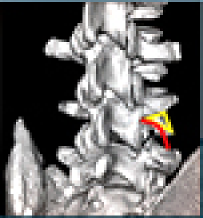

PAIN MANAGEMENT IN INTERVENTIONAL RADIOLOGY

Charles E. Ray, Jr.

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Pain Management in Interventional Radiology

As interventionalists become more involved with patients as care providers rather than solely as proceduralists, understanding and treating pain is a vital part of daily practice. This book provides an overview of the multiple techniques used in the management of pain in interventional radiology suites. Topics include techniques for the treatment and prevention of pain caused by interventional procedures, as well as minimally invasive techniques used to treat patients with chronic pain symptoms. Approximately half of the book is dedicated to the diagnosis and treatment of spinal pain; other chapters focus on intraprocedural and post-procedural pain management, embolization and ablation techniques used to treat patients with uncontrollable pain, and alternative treatments for pain relief. This book is a practical resource for anyone looking to acquire skills in locoregional or systemic pain control and wishing to improve the quality of life for patients undergoing procedures or suffering from disease-related pain.

Charles E. Ray, Jr., MD is Professor of Radiology, Co-Director of Research (Clinical), and Associate Residency Program Director at the University of Colorado Health Sciences Center, Aurora, Colorado.

To C. Eugene and Virginia L. Ray

Pain Management in Interventional Radiology

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Preface

Everyone feels pain. Everyone feels physical pain, to one degree or another. Pain, or simply the thought of being in pain, often changes our actions as no other physical sensation can. While often a necessary physical response to keep us out of harm's way (touching the hot handle of a pot, for example), pain becomes its own entity when it is associated with an underlying disease process.

Why is pain associated with disease? From an evolutionary perspective, was pain necessary for some reason to let the individual know that something was amiss (even though nothing could be done about it)? Was disease-associated pain used for some other, perhaps subconscious, purpose? Perhaps understanding the "why" is not all that important in today's world; after all, the bottom line is that pain simply hurts! And disease-associated pain can hurt most of all. We as health care providers should be able to do something about it – shouldn't we?

From one perspective, medicine (traditional or "Western" medicine in particular) has done relatively little to abate pain. Most of the major advances in pain control over the past 150 years have been in the field of pharmacology; general anesthesia is the prime example of pain control. With the exception of medications, however, little progress has been made in managing disease-associated pain over the past few decades. More work – much more work – remains. Shouldn't minimaliy invasive techniques spearhead this effort?

The goal of this book is simple. It is to provide the appropriate tools to the interventional radiologist, anesthesiologist, surgeon, or whoever else is interested in minimally invasive techniques to control pain before, during, or after procedures. Its intent is to provide an overview of multiple techniques used in pain management, to review the currently available literature regarding these techniques, and hopefully to act as a springboard to motivate practitioners and researchers alike to develop the next better mousetrap to care for our patients in pain. It is my sincere hope that someone, somewhere, will have an improved quality of life stemming from the reading of this book by their health care provider.

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Many individuals are secondarily involved in the publication of a book. Unfortunately, those who are most affected are often those with the least interest in the project. It is only through the support of those that surround us that an undertaking such as this is finished – or, for that matter, even begun. My sincerest thanks (a small token if ever there was one) to Bob Allen, MD, and my colleagues at Radiologic Specialists of Denver, Denver Health Medical Center, and the University of Colorado for providing whatever time and support they could during the generation of this text. Thanks are also extended to Beth Barry at Cambridge University Press, who has guided me through this book as well as another. I would also like to thank artist Stacy Erickson for her illustrations accompanying this book. The staff at the Society of Interventional Radiology, most notably Joy Gornal and Beverlee Galstan, were remarkably tolerant as their tasks were put on hold in order to meet another deadline related to this book.

Finally and foremost, my thanks and love are extended to my wife, Kris, for her endless support and unequaled patience during this project.

1

Pain Management in Interventional Radiology: An Introduction

Jason R. Bauer and Charles E. Ray, Jr.

THE PROBLEM OF PAIN

The management of pain continues to be one of the most vexing of problems for health practitioners worldwide. The pain response is difficult to manage for multiple reasons: responses vary widely in their mechanism of action as well as anatomic location; individual responses to pain are variable; secondary gains can be had by individuals falsely claiming to be in pain; cultural differences in description of pain and the willingness to admit to a pain response exist; even responses by the health care provider to a patient in pain varies widely. For these reasons, each and every patient who presents with pain, or in whom we as health care providers are likely to produce a painful response during a procedure, has a widely variable and largely unpredictable pain response.

Traditional medicine (so-called Western medicine) has demonstrated great advances in the management of pain; however, the advances have been relatively few and far between. Opium was cultivated for recreational use by the Sumerians nearly 5,000 years before it was first introduced specifically for medicinal purposes (1). It was not until 1680 that opium was introduced in England as Laudanum, a combination of opium, herbs, and sherry, specifically to be used for medicinal purposes. Although likely poorly understood at the time, the pain-relieving effects of opium must have significantly contributed to the use of opium as a medicinal agent. It is amazing, actually, that a plant discovered nearly five centuries ago remains the mainstay for pain relief throughout nearly all cultures and medical systems worldwide.

The next great advance in pain control was the discovery of agents used for general anesthesia during operations. The first public display of the effect of general anesthesia was performed at the Massachusetts General Hospital in 1846 (2). Dr. John Warren, a preeminent surgeon of the day, removed a vascular tumor from the jaw of a patient. This surgery was performed in conjunction with William Morton, a local dentist, serving as an anesthetist, by using an ether-soaked sponge under a glass dome. Upon awaking at the end of the procedure, the patient claimed he had no pain during the operation, to which Dr. Warren proclaimed to the audience (legend has it), "Gentlemen, this (anesthesia) is no humbug!"

One must take note that these two greatest advancements in the history of pain control – narcotics and general anesthesia – occurred a remarkably long time ago. Clearly, advancements have been made since then with regards to pain control, and the adjustments to the use of both narcotics and general anesthesia have allowed significant advancements in pain management. Other advancements, such as postoperative pain control with patient-controlled analgesia [described by Sechzer in 1971(3)] and the administration of intraprocedural sedation and analgesia, are the more recent improvements that have been major factors in pain management. However, if one regards the changes in other fields of medicine that have occurred since 1846 (antibiotics, chemotherapy for cancer, open heart surgery, transplant surgery, etc.), one is struck by the relative paucity of new methods of pain control, particularly long-lasting or "curative" pain control, that have occurred over the past several decades.

Western medicine has had a difficult time throughout its history in dealing with a patient in pain. One needs look no further than the number and types of alternative therapies available to individuals to treat pain. Chiropractic, napropathic, and homeopathic medicine forms largely deal with patients in pain, as does acupuncture, massage therapy, craniosacral therapy, and many others. Are the successes of these alternative medicine systems in treating patients in pain in part due to our failure as traditional medicine providers?

If Western medicine has largely fallen short when dealing with the patient in pain, interventional radiology (IR) has in many ways ignored the problem altogether. Except for giving a touch of sedation and analgesia during our procedures, or occasionally treating the patient in pain with a nerve block, spinal procedure, or embolization, IR provides very little attention to the patient in pain. This is perhaps historical as much as anything; because IR started as a diagnostic modality where our contact with any given patient extended for only an hour or two; the need to understand the pain response and the best way to treat it was underappreciated. It has only been because we as interventionalists have become more involved with patients as care providers rather than proceduralists that the need to understand patients in pain has become more vital to our daily practice.

PAIN IN MEDICINE AND SOCIETY

Pain, and the treatment of pain, is an enormous medical/social issue. From a societal standpoint, the cost of pain is tremendous. One study evaluated nearly 30,000 workers in the U.S. workforce, and estimated that the total cost of lost productivity in the workplace because of common pain conditions (headache, arthritis, back pain, and other musculoskeletal pain) was $61.2 billion per year (4). The same study noted that the majority of the lost productivity was due to reduced performance while at work, rather than taking time off.

The costs (in dollars) associated with pain control are nearly impossible to accurately calculate. One study evaluated 373 cancer patients, nearly 40% of who reported having some sort of cancer-related pain (5). Of these patients, three-quarters incurred a pain-related expense, averaging $891 per month

Table 1. Results from PubMed Search, January 2007

Search Term	*Number of Articles Returned*
"Pain"	341,298
"Pain," limited to last one year	18,569
"Pain, interventional radiology," limited to last one year	19

related specifically to pain control. Other studies have evaluated common conditions such as low-back pain, which in terms of both direct costs and indirect costs (lost productivity, etc.), is likely the most costly medical problem facing the medical establishment in the United States. In 1991, low-back pain was estimated to cost the United States $25 billion in *direct costs alone* (6,7). It has also been estimated that 80% of all adults at some point in their lifetime will seek medical care of some sort for low-back pain and that a third of all disability costs in the United States are due to the same problem (6,8). Clearly, pain management represents a huge percentage of both the time and dollars spent on health care in this country.

Medically, the search for improvement in pain management is also consuming when one considers the amount of research time (and dollars) spent on pain control. The importance of research into pain and the management of pain are revealed when one considers the attention given to pain by the National Institutes of Health (NIH). The NIH has previously focused attention on pain research with the development of multiple committees, such as the NIH Pain Research Consortium, the NIH Extramural Pain Staff Workgroup, and the NIH Pain Interest Group, specifically charged with attempting to drive more research into pain control (9).

Also illustrative of the research efforts regarding pain management, over twenty journals are dedicated to pain, with such widely varied titles as "Pain," "Journal of Orofacial Pain," and "Molecular Pain" (whatever THAT may be!). At the time of the manuscript preparation, a PubMed search was performed with the single keyword "pain" (Table 1). A total of more than 340,000 articles were returned. When limited to manuscripts published within the past year, nearly 19,000 articles were returned. Amazingly, when the keywords "interventional radiology" were added to the search, only 19 articles were returned for a one-year time period. Clearly, we as interventionalists have some catching up to do with regard to understanding the importance of pain management for our patients.

IR AND PAIN MANAGEMENT

The role of IR in pain management varies widely from institution to institution, from practice to practice, and from operator to operator. To try to define pain management as a major or minor player in the field as a whole is impossible, and each individual practitioner must determine the needs of the patient, the referral patterns for their individual practice, and their own desire to become involved with pain management to decide what amount of time and effort will be spent on the management of pain. At one of the authors' (CER) institutions, for instance, the number of pain procedures we have performed over the past two years has increased by a factor of 2.7, largely due to increased involvement with low-back pain management. Parenthetically, the number of procedures performed for an indication of pain still only accounts for 5% of all the cases performed at that one institution.

One instance in which we all must be involved in pain management, however, is in controlling the pain (and anxiety) that we specifically cause during procedures performed for other reasons. It is in this management of intraprocedural pain that we all have a common interest. Intraprocedural pain control is important for several reasons. As described by the American Society of Anesthesiologists in their practice guidelines for sedation and analgesia by nonanesthesiologists (10), the goals of intraprocedural sedation and analgesia are twofold. First, it ". . . allows patients to tolerate unpleasant procedures by relieving anxiety, discomfort, or pain." Second, ". . . in children and uncooperative adults, sedation-analgesia may expedite the conduct of procedures that are not particularly uncomfortable but that require that the patient not move" (10). Control of intraprocedural pain is important for other reasons as well, particularly if the same patient is going to return to the same interventionalist for repeat procedures. Nothing will dissuade an individual from returning for repeat procedures quite like a previously painful experience!

Pain management in IR has evolved over time. Intially, nearly completely ignored except for the use of local anesthetics at the skin entry site, increasing attention was paid to pain control needed during the procedure itself, with widespread use of intraprocedural sedation and analgesia. Procedures specifically designed to treat a patient's underlying pain, such as embolization or ablation of painful osteolyses, were developed. Finally, again with our increasing involvement in patient care, further attention has been given to postprocedural management of pain. For these reasons, many IR divisions are now considered along with anesthesia, neurology, neurosurgery, oncology, and orthopedic medicine, as one of the "pain services."

The use of intra-arterial injection of local anesthesthetics provides an example of the evolution of pain management in IR – a brief synopsis is given in the following paragraphs.

USE OF INTRA-ARTERIAL LOCAL ANESTHETICS

The use of intra-arterial anesthetics in the management of pain is relegated to few uses today. From a historical perspective, the use of these agents intravascularly was linked to the evolution of angiography and the pain resulting from contrast injections (11,12). There has been a reemergence of intra-arterial analgesia in IR largely as a result of increased interest in transcatheter tumor therapy.

As early as 1939, adjuvant injection of medications to limit pain experienced during peripheral angiography was explored. Procaine hydrochloride (Novocaine) injection was mentioned by Dimitza and Jaegar with apparently improved pain during peripheral angiography (11). In 1982, Cranston performed a double-blinded placebo-controlled trial of thirty-four patients having peripheral angiography (13). Subjective and objective evaluations were performed using verbalization and movement. One milliliter of 2% lidocaine was mixed for each 10 ml of Conray-60 used. Seventeen patients received lidocaine during the first injection of contrast, thirteen during the second injection, and four received two injections without contrast. All patients who received lidocaine in the first injection reported subjective improvement, and there were no associated complications.

The debate regarding effectiveness or need for intra-arterial lidocaine administration during peripheral angiography is now all but moot. With the evolution of digital subtraction angiography (using less contrast at lower rates) and low osmolality contrast agents such as Visipaque (GE Healthcare, Cork, Ireland), few patients experience symptoms so intolerable as to warrant intra-arterial lidocaine.

When considering transcatheter tumor therapy for malignant tumors, such as hepatocellular carcinoma in the liver, or benign tumor management, such as symptomatic leiomyomata in the uterus, pain management strategies have included intra-arterial lidocaine injection. In 1990, Molgaard et al. injected intra-arterial lidocaine in the hepatic artery prior to and during Transcatheter arterial Chemoembolization (TACE) in 45 patients (14). Analgesic requirements during and following the procedure were compared with that in 20 patients previously treated without intra-arterial lidocaine (14). They found a remarkable decrease in the amount of medication required during (98.9% decrease in narcotic dose) and after (75% fewer individuals requiring a patient-controlled analgesia pump) the procedure in those who received lidocaine. Lee et al. evaluated the importance of timing of intra-arterial lidocaine injection (15). In 113 consecutive patients, three groups of patients (no lidocaine, lidocaine just prior to TACE, and lidocaine following TACE) were evaluated by quantifying the mean dose of analgesic and subjective pain score. There was a statistically significant difference in both the amount of analgesics used and the pain score; those patients who received 100 mg of lidocaine prior to TACE used fewer narcotics and reported a lower pain score than those receiving similar treatment administered after delivery of the chemotherapeutic agent. The authors reported few complications, with only one patient experiencing transient hypotension.

Intra-arterial lidocaine has also recently been investigated during the endovascular treatment of uterine fibroids. Embolization in this setting notoriously results in a postembolization syndrome, punctuated by pain and cramping. Postprocedural pain in this setting may extend the length of hospital stay and lead to return visits. Similar to TACE, pain is thought to result from leiomyoma ischemia, spasm, and parenchymal swelling (16). However, uterine arteries do not appear to respond to lidocaine in the same way as hepatic arteries following injection of intra-arterial lidocaine; this may be due to their need to meet the demands of a gravid uterus (17). Keyoung et al. injected 200 mg of lidocaine in 10 consecutive patients (while eight received placebo) prior to uterine artery embolization (UAE) for leiomyomata (17). Lidocaine was found to significantly improve subjective pain reported by patients but not the amount of analgesia required following the procedure. More importantly, moderate to severe vasospasm was noted in seven of ten patients after lidocaine; none of the placebo patients demonstrated such spasm, resulting in early termination of the study. Vasospasm due to lidocaine injection may therefore contribute to a higher treatment failure rate and therefore is not commonly used during UAE.

Intra-arterial lidocaine was once common during peripheral angiography; its safety profile has been supported during years of use for this application. With overall few reported complications, intra-arterial lidocaine injection prior to tumor embolization provides practitioners with a safe strategy to achieve better patient comfort during and after embolization procedures.

CONCLUSIONS

"Pain management continues to be the most difficult problem facing medicine today." This statement is debatable, but arguments against it are largely due to a matter of degree and opinion, not of underlying substance. The patient in pain is ubiquitous, regardless of culture, geographic location, socioeconomic status, sex, race, or any other variable of which we can think.

IR can play a major role in pain management and is unique as a field in that we can be responsible for controlling patients' pain as a primary goal of therapy, or in controlling the pain that we cause during our procedures. This book is organized in such a way, with chapters on intraprocedural and postprocedural pain management, and multiple chapters on procedures performed specifically to treat underlying processes that may be responsible for the pain response. Special attention is given to spinal procedures, although other publications provide a more in-depth overview of spinal procedures. The goal of this book is to provide an overview of pain management in IR and introduce concepts that can be used on a daily basis in the interventional suite to better provide pain management for our diverse group of patients.

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2

Clinical Evaluation of Low-Back Pain

Anthony P. Dwyer, Curt Freudenberger, and Vikas V. Patel

INTRODUCTION

The goal of this chapter is to explain the mindset and thought processes of the clinician evaluating a patient presenting with symptoms of low-back and leg pain.

The accurate clinical evaluation of the symptom of low-back pain is essential to the successful management of patients presenting with this problem, and interventional radiology (IR) plays an important role in the process.

It is vital to recognize that low-back pain is only a symptom and not a diagnosis or a disease entity in and of itself. Unfortunately, the successful management of patients with low-back pain is difficult because of the diversity of the pathologies producing low-back pain. There are many pathologies that can produce the symptom of low-back pain, and its treatment is very difficult or impossible unless one can locate and understand the causative pathology. The key to successful management of patients presenting with low-back pain is to identify and understand the pathological cause of their presenting symptoms of low-back pain, and to direct therapy toward the underlying cause rather than solely relieve the symptom of pain.

Although low-back pain typically arises from spinal causes, it must be remembered that there are pathologies outside of the spinal column that can present with low-back pain. These etiologies are typically considered only after a spinal column abnormality has been excluded.

A useful classification of the causes of low-back pain is the classification scheme described by Macnab et al. (1). These are presented in Table 1.

Another diagnostic hurdle is the difficulty in determining whether the pathologies identified on spinal imaging are the cause of the low-back pain or coincidental to it, as a significant percentage of asymptomatic patients have pathology identified on spinal imaging [especially on magnetic resonance imaging (MRI)] (2). Not infrequently, clinical examinations, patient symptoms, and imaging studies are discordant. Spinal interventions are often requested as a method by which to determine whether or not the pathology

Table 1. Classification Scheme for the Causes of Low-back Pain

Viscerogenic
Vascular
Neurogenic
Psychogenic
Spondylogenic
Traumatic
Infectious
Neoplastic
Metabolic

Source: Macnab et al. (1).

noted on the imaging study is responsible for the patients' pain. This subject is beyond the scope of this chapter and is discussed in the individual, procedurally oriented chapters that follow.

This chapter will concentrate on the clinical evaluation of the more common spinal pathologies that affect the vast majority of low-back pain patients in clinical practice. Oftentimes, regardless of the underlying cause (e.g., traumatic, infectious), the symptom of pain itself is caused only after significant degenerative changes have occurred within the spinal column.

LUMBAR PAIN OVERVIEW

By definition, *somatic* pain occurs with noxious stimuli to musculoskeletal structures, *visceral* pain occurs with noxious stimuli to an organ, and *neurogenic* pain occurs with noxious stimuli to axons and cell bodies. *Referred* pain is felt at a location away from the site of the causative pathology, with the site of pain being innervated by nerves different than the structure causing the referred pain. It must be remembered that virtually any structure receiving innervation is a potential source of pain when it is at the site of pain-producing pathology.

With lumbar pain, the causative pathology usually involves the structures of the disc and facet joints involved in degenerative cascade, as described in depth by Yong-Hing and Kirkaldy-Willis (3). Sources of lumbar pain are outlined in Table 2 (4).

Lumbar pain can be axial (central lumbar) or may radiate from the spine. The latter cause is felt as deep, aching, poorly localized pain usually in the buttocks and thighs. This latter constellation of symptoms is referred to as "somatic referred pain." Radicular pain arises from involvement of the spinal nerves with inflammation, irritation, and compression, producing a sharper pain localized in the radicular distribution of the involved nerve root. Radicular pain is often associated with objective neurological deficits, the most notable of which are sensory change and muscle weakness. Clinical studies have

Table 2. Anatomic Sources of Lumbar Pain
Vertebra
Disc
Facet joints
Sacroiliac joints
Muscles
Ligaments
Dura
Source: Van Akkerveeken et al. (4).

established that nerve root compression alone does not produce radicular pain and that the nerve root must first be inflamed in order for compression to produce pain. These studies also confirmed the outer annulus as the common site of lumbar pain, with the facet joint capsule only occasionally being a cause (Figure 1) (5).

The vast majority of low-back pain is mechanical in nature and is usually related to spinal degeneration, or subclinical episodes of "wear and tear" that are aggravated intermittently by episodes of trauma. This "degenerative cascade," as described by Yong-Hing and Kirkaldy-Willis (3), is ubiquitous; its extent and severity is multifactorial, such as genetic predisposition, smoking, and occupational loads to the lumbar spine. The degenerative cascade produces degenerative joint changes in the articular cartilage of the facet joints, loss of hydration of the intervertebral disks with concomitant loss of stability and resistance to torsion, eventually leading to radial

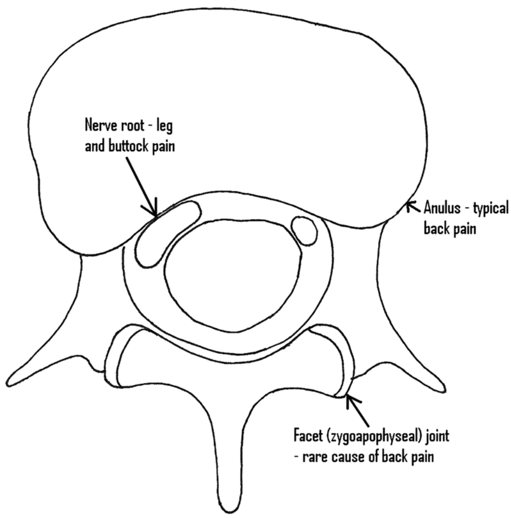

Figure 1. Possible sites of lower back pain. (From Kuslich and Ulstrom (5)).

tears in the annulus. These annular tears allow herniation of the disc material out of the disc into the vertebral canal and onto the adjacent nerve root, causing the symptom of "sciatica" or pain in the distribution of that involved nerve root. The damaged disc also releases neuropeptide, phospholipase A2, and inflammatory peptides, further irritating the nearby neurological structures (6).

The Clinical Evaluation Process

In the initial evaluation of a patient with low-back pain, an initial triage process must occur to determine the need for urgent intervention. One such example of a triage algorithm is given in Figure 2 (7).

Once a surgical emergency has been excluded, a more systematic evaluation of the patient with low-back pain can occur. To illustrate the evaluation process at our institutions, we present the following sample history questions and issues to be resolved from the physical examination.

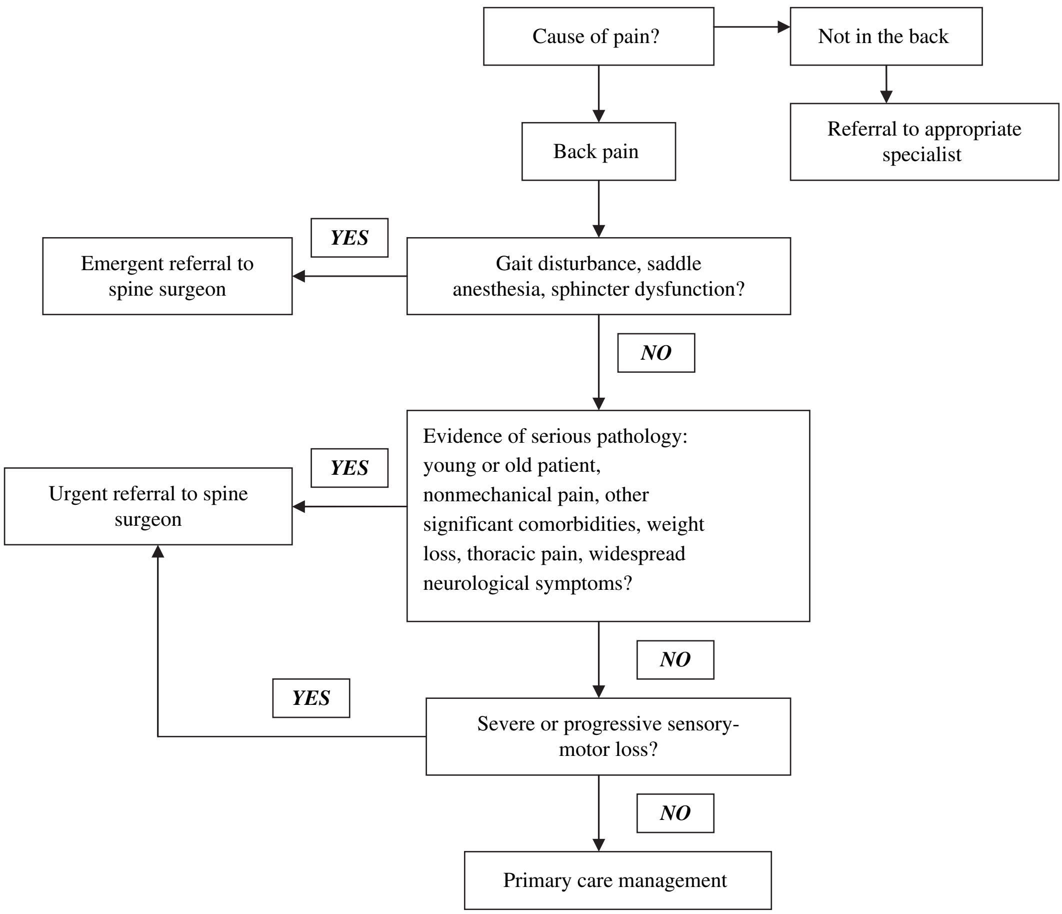

Figure 2. Sample algorithm for the clinical evaluation of low-back pain. (From Waddell (7)).

HISTORY

For the history, the following questions are asked:

- "Where is the pain the worst – the back or leg?"
- "Is the pain *mechanical* (i.e., worse with activity and relieved with rest) OR *nonmechanical* (i.e., having red flag or sinister symptoms of weight loss, fevers, worse at night and at rest)?"
- "Are the leg symptoms '*radicular*' (shooting and bandlike, from irritation of a spinal nerve or root) OR '*referred*' (deep, diffuse, poorly localized and aching, from irritation of the nerves supplying the structures of the vertebral motion segment [e.g., annulus, facet joint])?"
- "If there is claudication, is it *neurogenic* (from ischemia and compression of the nerve roots, arising from a central or lateral spinal stenosis) OR *vascular* (reproducible, relieved by rest, from leg muscle ischemia arising from peripheral vascular disease)?"
- "Are there symptoms of cauda equina syndrome? (bladder and bowel sphincter dysfunction)?"

PHYSICAL EXAMINATION

During the physical examination the examiner will record:

- Spinal deformity
- Spinal range of motion and any symptoms produced
- Hip and knee range of motion and any symptoms produced
- Objective neurological deficit (reflex loss, wasting, weakness)
- Subjective neurological deficit (sensory loss)
- Nerve root irritation (sciatic or femoral nerve stretch test)
- Distal pulses and any ischemic leg skin signs (loss of hair, skin discoloration, "shiny" skin appearance)
- Perianal and rectal examination findings in patients suspected of having cauda equina syndrome

RADIOLOGIC INVESTIGATIONS

Different radiologic modalities provide different data that can be instrumental in the evaluation of a patient with low-back pain. A specific imaging modality may be vital in one clinical scenario and worthless in another, and rarely are all modalities (radiography, nuclear medicine scans, computed tomography (CT), MRI, invasive techniques) necessary (8). In order to best utilize such resources, algorithms that suggest the most appropriate utilization of radiologic studies have been produced. Some general rules of thumb regarding what information can be gleaned from the different imaging modalities follow.

RADIOGRAPHS

Anterior/posterior, lateral, oblique views and flexion/extension radiographs of the lumbar spine provide the following clinically important information:

- Number of normal lumbar levels, the intercristal line, the length of the L5 transverse process, and any thoroco-lumbar or lumbo-sacral anomalies

- Secondary and primary signs of degenerative disc disease and degenerative facet joint disease
- Coronal or sagittal deformities of alignment
- Pars interarticularis defects
- Stability of the spine on flexion/extension lateral radiographs
- Evidence of osseus destruction from infection or neoplasm

CT AND MR IMAGES

Cross-sectional imaging studies provide the following clinically important information:

- Disc space narrowing with loss of T2 signal indicating degenerative disc disease
- Facet joint enlargement, effusion, and/or cyst formation, indicating degenerative facet joint disease
- Central stenosis, usually from ligament flavum hypertrophy or inferior facet joint hypertrophy
- Lateral stenosis, usually from superior facet hypertrophy and medial displacement
- Disc displacement
- Vertebral canal tumors
- Dural cysts

ELECTROMYELOGRAPHY/NERVE CONDUCTION VELOCITIES

Information provided by electromyelography/nerve conduction velocities is vital, particularly as evidence for physiologically significant disease. These physiological studies are particularly effective in diagnosing the following:

- Peripheral neuropathy
- Radiculopathology
- Spinal stenosis

IR REFERRAL

Referrals to IR are not all that frequent when considering the number of patients seen in a spine pain clinic. Select patients, however, may benefit greatly from IR procedures. Evidence-based medicine for IR procedures is distinctly lacking, and there are no widely accepted algorithms for when an IR procedure is indicated. The clinician will consider an IR referral to effect the following:

- Improve low-back and leg symptoms (the various forms of epidural steroids injections and nerve root blocks)
- Identify the "pain locator" by placing a needle in a specific anatomic location, first to reproduce the symptoms and second to relieve the symptoms (e.g., discograms)
- Confirm the specific level and side of the causative pathology (selective nerve root blocks when there is bilateral or multilevel pathology)

The results of these IR procedures are just one piece of the clinical evidence that assist the clinician in deciding what therapy (e.g., spinal decompression, fusion) is indicated, and at what locations and levels.

SELECT IR SPINAL PROCEDURES: A CLINICIAN'S PERSPECTIVE

Discography

The clinical use of discograms remains controversial. The pathogenesis of discography-induced pain reproduction is poorly defined (9–13). Critics describe unsatisfactory sensitivity and specificity rates and the lack of correlation between a positive discogram and successful treatment as evidence that discography should not be utilized in the evaluation of discogenic pain. Conversely, advocates of the technique point out that the accuracy of clinical and radiologic evaluations are just as poor in predicting postoperative clinical outcomes. The authors believe that discography can be helpful in select patient populations when deciding if surgery is indicated, and if so, what levels need to be addressed.

In an attempt to reduce the problem of false-positive or false-negative discograms, the International Spine Injection Society recommends some standardization (14):

- Recording of volume and injection pressure of the injected contrast
- Correlation with the patients' symptoms, to decide if there is clear symptom reproduction (i.e., the pain caused by the discogram is "concordant" or "non-concordant" with the patients' underlying symptoms)
- Description and classification of the contrast injection on postprocedure radiographs and/or CT (15)
- Injection of anesthetic into the disc at completion of a positive discogram, and the keeping of a postprocedure pain diary to determine the duration of any pain relief

Selective Anesthetic Blocks

The philosophy of the successful use of anesthetic blocks has not been based on objective or blinded studies. These procedures have been handicapped by the lack of definitive evidence supporting their use, the very subjective nature of the blocks, and the placebo effect. Some authors maintain that the placebo effect can be minimized if the following injection sequence is followed with the appropriate time interval (e.g., two weeks) between injections:

- Normal saline
- Short-acting local anesthetic (e.g., 1–2% lidocaine)
- Longer acting anesthetic (e.g., 0.25% bupivicaine)

A positive block is one that has symptom reproduction on injection of contrast and shows no relief with the saline injection, short-term relief with the short-acting anesthetic, and longer relief with the longer acting anesthetic. Subjective relief of 50–75% of the patient's underlying pain is considered diagnostic.

Table 3. The Role of various Interventional Spine Procedures: A Clinician's Perspective

Injection/ Procedure	*Radiological Confirmation Required*	*Diagnostic of Pain Locator*	*Therapeutic Effect*	*Surgical Decision Making*
Discography	++	+++	–	+++
Epidural steroids	++	–	+++	+/–
Facet joint blocks	+/–	+/–	+++	+/–
Median branch blocks	+/–	+/–	+++	+/–
Sacroiliac joint blocks	++	+++	++	++
Nerve root blocks	++	+++	+++	+++

SUMMARY

The clinician's expectations of the various IR procedures presented here are summarized in Table 3. These include:

Discography (16)

- Finds the pain/symptom source or "pain locator."
- Determines if the "black disc" on T2 is the pain locator and the source of symptoms
- Determines what levels need to be included or excluded in the fusion construct, for example, whether L4/5 needs to be included in the fusion of an L5/S1 spondylolisthesis.

Selective Nerve Root Blocks (17)

- Determine which nerve roots are involved in the symptom production when there are multiple roots involved on imaging studies.
- Provide a period of symptomatic relief, which may be either short (temporary) or prolonged (definitive). This period of symptom relief may afford the patient an opportunity to derive benefit from physical therapy and other nonoperative treatments.

Epidural Steroid Injections (18,19)

- Provide symptom and functional improvement (mainly for radiculopathy from disc herniation and spinal stenosis), and allow temporary nonoperative symptomatic improvement.

Facet Blocks (20–23)

- Can determine the source of pain in patients in whom no other source can be identified
- Allow the clinician to stop evaluating other potential sources of spinal pain
- Can provide relief for 3–4 months

Sacroiliac Joint Blocks (24)

- Provide symptomatic and functional relief, either as a standalone method or in combination with other nonoperative treatments
- Determine if the sacroiliac joint is the pain locator
- Allow the clinician to stop evaluating other potential sources of spinal pain

Interventional radiologic procedures play an important role in both the diagnosis and treatment of spinal back pain in select patient populations. Close communication with the referring spine physician is vital to performing the appropriate imaging-guided procedure.

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PART I

Locoregional Pain Control

3

Local Anesthetics

Jan Namyslowski

HISTORY

Ruetsch et al. provide an in-depth review of the history of local anesthesia in their 2001 paper titled "From Rocaine to Ropivacaine: The History of Local Anesthetic Drugs" (1). What follows is a summary of pertinent points in their eloquent historical review.

Cocaine has its linguistic origin in a Peruvian plant, revered by the natives for its stimulating properties. The word *Khoka,* meaning "the plant," evolved into the European *coca* over time. We owe the term *cocaine* to Albert Niemann who isolated the main alkaloid from the coca leaves. A Viennese pharmacologist, Karl Damian Ritter von Schroff, described coca-induced skin insensibility. Samuel Percy was "the first to propose the use of the coca leaves as an anesthetic" in 1856. Carl Koller, in 1884, first used cocaine for ophthalmological anesthesia at the suggestion of Sigmund Freud. Addictive properties of cocaine were soon discovered as well, and many practitioners became affected, Freud and William Halsted among them. The dependency placed a significant damper on the availability of local anesthesia for medical procedures.

Subsequent pharmacological advances have led to the development of several local anesthetic compounds in the late 19th and throughout most of the 20th centuries. The delivery of local anesthetics would not have been possible, were it not for the invention, in 1844, of a hollow hypodermic needle and syringe by an Irishman, Francis Rynd (2). Rynd's clinical contributions, although not arrived at in an FDA-approvable style, allowed for a significant medical progress at the time:

> The subcutaneous introduction of fluids, for the relief of neuralgia, was first practised in this country by me, in the Meath Hospital, in the month of May, 1844. The cases were published in the "Dublin Medical Press" of March 12, 1845. Since then, I have treated very many cases, and used many kinds of fluids and solutions, with variable success. The fluid I have found most beneficial is a solution of morphia in creosote, ten grains of the former to one drachm of the latter. (3)