Interventional Pain Procedures: Understanding their Role in Clinical Practice
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Abstract:
Chronic pain is one of the most challenging problems facing physicians today. In recent years it has been recognized that a compartmentalized approach to managing these patients results in unsatisfactory outcomes. A more integrated approach using a multidisciplinary model results in more efficient resource utilization. Interventional pain procedures are one of the tools available to help alleviate chronic pain. Epidural steroid administration and facet injections are basic techniques with a long history in the treatment of chronic pain. Cancer-related pain is also amenable to interventional therapies in select patients. With an ever increasing number of interventions targeting various anatomic structures, interventional pain practitioners continue to refine and explore where these techniques fit into clinical practice.

Background
Chronic pain continues to be one of the most difficult clinical problems physicians face. Part of this stems from physicians' training which considers the treatment of pain in a reductionist, purely biological model. This model defines pain as a purely sensory event caused by the activity of certain nerve fibers. Treatment is geared solely at symptom reduction, without taking into account other issues such as disability or depression.

When dealing with patients with chronic pain, there often is no test and not one specific solution to their problem. However, this does not mean chronic pain cannot be adequately managed. As physicians we must alter not only our own perceptions, but our patients' perceptions as well. We must look at the treatment of chronic pain as an ongoing process. Instead of trying to find the one modality that “fixes” the problem, we must educate our patients regarding the myriad of tools we have available to alleviate pain and improve their ability to cope with their pain.

One of the greatest problems patients with chronic pain face is the perceived lack of control over their condition. They never know when they may have a bad day and be almost unable to function secondary to their pain. Having a patient know that there is something that can be done can be helpful in the management of chronic pain. Interventional approaches are an important tool available to help alleviate pain and to offer some degree of control over his/her pain.

In the last 15 years it has been recognized that the traditional pain treatment model - patients are initially seen by their primary care physician, then referred to a secondary specialist (interventional pain, occupational medicine, etc) and finally may see a tertiary specialist such as a neurosurgeon - may lead to inefficient resource utilization (1). An alternative model to this is the multidisciplinary pain center (MPC). This model attempts to take a more holistic view of the treatment of chronic pain by incorporating physicians, interventionalists, psychologists, physical therapy, occupational therapy and perhaps other professionals into the treatment of patients with chronic pain. In large tertiary referral centers, this model works well. Unfortunately, many providers in smaller centers may not have the resources available to create a full fledged MPC. However, the underlying concepts of the MPC can still be useful (Table 1).

Painful conditions which may be amenable to interventional therapies range from trigger point injections for fibromyalgia to spinal cord stimulation for failed back surgery syndrome. As with most other therapeutic options in the treatment of chronic pain, interventional procedures by themselves will seldom lead to complete resolution of patients' complaints. However, when used in conjunction with reasonable medical management protocols, physical therapy and adequate support, interventional pain management can help patients keep their pain at a level which minimally affects their ability to function.

This article will describe the targets of interventional procedures and briefly summarize their role in clinical practice. Additionally, we will discuss the potential role of interventional pain management in the treatment of cancer-related pain. Finally, we will briefly touch on more advanced techniques such as spinal cord stimulation. We will not go into the details of potential treatment options for sympathetically mediated pain such as reflex sympathetic dystrophy (RSD) or complex regional pain syndrome (CRPS); however, we will address some of the important studies helping to define clinical outcomes and efficacy.

Targets of interventional pain procedures
Interventional pain procedures target well defined anatomic structures, important in either the generation or the transmission of pain. Interventional pain techniques commonly target the following:
1) Specific inhibition of inflammation

2) Interruption/ablation of the transmission of pain

3) Interruption/ablation of sympathetic fibers in the progression of pain

Epidural steroid injections are believed to have their therapeutic effect by minimizing nerve root inflammation secondary to intervertebral disk herniation. Transforaminal injections can be useful in the diagnosis of radiculopathy by isolating the affected nerve root and giving prognostic information of surgical decompression. Complex regional pain syndrome (CRPS) type 1 is believed to arise from dysfunction of the sympathetic nervous system of the affected extremity. Ablation of sympathetic fibers (stellate ganglion, lumbar sympathetic chain, etc.) can inhibit or reverse the changes of CRPS (RSD).

Basic Interventional Pain Techniques

Epidural Steroid Injections

The first reported use of epidural steroid injections (ESI) was in 1952 by Robecchi and Capra (3) for the treatment of sciatica. The use of ESIs has continued for the treatment of radicular pain since then in varying permutations. The evaluation of radiculopathy includes plain x-rays to evaluate the bony structures of the lumbar spine, MRI to evaluate the soft tissue structures such as nerve roots and intervertebral discs, electrodiagnostic studies to differentiate peripheral neuropathy from radiculopathy and CT myelography to evaluate the osseous structures and the spinal canal (4).

ESIs are commonly performed in the cervical and lumbar regions of the spine. Thoracic injections are also employed. However, true radicular pathology in the thoracic region is much less common than in the cervical and lumbar regions. The mechanism of action of ESIs is believed to stem from the potent anti-inflammatory activity of corticosteroids. Disc herniation occurs when the annulus fibrosis of the disc ruptures, and the nucleus pulposus is pushed into the spinal canal. The herniated nucleus pulposus material contains several pain associated neurotransmitters and causes a significant amount of inflammation. These substances cause inflammation in the nerve root, often resulting in the perception of pain. Corticosteroids are very effective in inhibiting the inflammatory cascade and thereby relieving pain.

A published meta-analysis in 1990 showed a statistically significant improvement in patients suffering from radiculopathy. However, at the time there were few controlled studies to choose from (5). In the last 15 years there have been many trials undertaken to elucidate the efficacy of ESIs. Manchikanti and colleagues reviewed randomized and non-randomized trials in 2003 for the three commonly performed ESIs (intralaminar, transforaminal, and caudal). Evidence for short term relief was excellent and for long term relief was moderate (6). This again reinforces the idea that treatment of chronic pain is a continual process, and the likelihood of one therapeutic option completely alleviating all of a patient’s symptoms is unlikely. However, ESIs are a useful tool in the management of patients with chronic pain.

Facet Joint Procedures

Pathology of the facet joint has long been known to cause back pain (7). Facet joints are paired synovial joints formed by articular process of the superior and inferior level. Facet pain tends to be referred to the lower back, hips and anterior thighs. “Facet syndrome” is characterized by symptom exacerbation with extension of the spine, localized tenderness in the region overlying the facet, absence of leg pain and radiographic evidence of arthritic changes in the facet joints (8-10).

The two major interventions targeting the facet joint are intraarticular steroid injections and medial branch blocks/ablation. Intraarticular steroids exert their effect via reducing inflammation in the facet joint. The mechanism is the same as seen in the intraarticular injection of corticosteroids into the hip or knee for degenerative joint disease. Corticosteroids decrease inflammation and suppress production of painful neurotransmitters. Medial branch blocks are a technique to block the transmission of pain from the facet joint. The medial branch of the dorsal posterior primary rami innervates the facet joint and is accessible with fluoroscopically directed injections. If patients receive at least short term benefit from the injection of local anesthetic, they may be candidates for permanent denervation with radiofrequency lesioning of the medial branch.

The key to successful outcomes with radiofrequency lesioning of the facet joint is appropriate patient selection. Rigorous technique must be employed to appropriately target the medial branch, and patients should be asked to keep a pain diary for at least 48 hours after the injections to evaluate efficacy.

It is difficult to interpret the clinical data on outcomes of facet denervation because of a lack of well-validated, diagnostic criteria and patient selection difficulty. Two prospective, double-blinded studies showed long term benefit from radiofrequency denervation (11, 12). Conversely, another study with slightly less rigorous selection criteria showed no benefit (13).

Management of Cancer-related Pain

Interventional pain management for cancer-related pain must be viewed differently than the management of non-malignant pain. Generally, neuroablative procedures which would only be used in extreme cases in non-malignant pain are considered earlier in the course of therapy.
Perhaps the most well known interventional procedure for cancer-related pain is the celiac plexus block. Commonly performed for pancreatic adenocarcinoma and cancer of the upper abdominal viscera, celiac plexus ablation can augment medical management in certain circumstances (14). This procedure takes advantage of the innervation of the upper abdominal viscera by afferent nociceptive fibers traveling in the sympathetic fibers of the splanchnic nerves arising from T5-T12 and the parasympathetic efferent fibers that make up the celiac plexus. The fibers are in the retroperitoneal space adjacent to the L1 vertebral body. This block can be done using simple surface landmarks; however, in recent years the use of either fluoroscopic or CT guidance has become commonplace. Most centers will perform a diagnostic block before performing a neurolytic block with phenol/alcohol or radiofrequency thermocoagulation.

Additionally, other ablative procedures can be used for the treatment of invasive malignancy. Pain from tumor invasion of chest wall structures can potentially be improved with intercostal nerve ablations. The data supporting this is not as well established as the celiac plexus block, but if more conservative management has failed, it certainly deserves consideration (15).

Finally, direct administration of therapeutic agents to the epidural or intrathecal space may be considered. There are a variety of ways to attain access for drug delivery, ranging from short term options such as simple epidural catheters to very expensive intrathecal infusion devices which are programmed for continuous and bolus delivery of medications. In general, patients to be considered for the implantable devices should have a life expectancy of at least 6 months because of the invasiveness of the procedure and expense of the device itself.

**Spinal Cord Stimulation**

Spinal cord stimulation has its roots in the gate control theory of pain perception. In this theory retrograde stimulation of large fibers (non-pain conducting pathways) would inhibit smaller fibers (pain conducting delta fibers) and thus stop perception of pain at the spinal cord level (16). The first spinal cord stimulators were implanted in the 1960’s. In spinal cord stimulation, an array of stimulating metal electrodes is positioned in the dorsal epidural space. An electrical field is generated through connections with a pulse generator. The resulting field stimulates the axons of the dorsal columns, leading to inhibition of the activity in the lateral spinothalamic tract and increased activity in the descending anti-nociceptive pathways (17). In recent years the exact mechanism of pain relief from spinal cord stimulation has been recognized as being more complex than a simple “closing of gates” in the ascending pathways. However, inhibition of the ascending fibers clearly plays a role (18).

Spinal cord stimulation is used as late stage therapy in certain conditions after pharmacologic, non-pharmacologic and less invasive therapies have failed. Neuropathic pain tends to respond better to spinal cord stimulation than nociceptive pain. Patients which tend to respond well to spinal cord stimulation are patients with predominantly lower extremity symptoms (chronic radiculopathy, CRPS Type 1 (RSD), etc.). However, relief of axial lower back pain can be obtained in select patients.

A trial employing a temporary epidural catheter is commonly performed before permanent implantation. If patients achieve at least 50% reduction in their pain and are able to tolerate the sensation associated with stimulation, they are considered good candidates for permanent implantation.

A recent randomized controlled trial comparing spinal cord stimulation with lumbar re-operation showed better pain outcomes in the stimulation group (19). A review of the older literature showed 60% of patients with spinal cord stimulator implants had what they considered good control of their pain (>50% reduction) (20). With advances in the ability to program leads and in battery life, these outcomes can hopefully be improved upon.

**Conclusion**

Treatment of chronic, nonmalignant pain syndromes continues to be an ongoing challenge for clinicians. Recent advances in technology and imaging have allowed greater accuracy and a wider variety of therapies to be offered to patients. However, the recognition of the need for a more integrated approach to the use of these advanced techniques continues to be a major challenge to interventional pain physicians. These interventions do not supplant pharmacologic and non-pharmacologic modalities to treat chronic pain; their role is complementary (7).

Just as interventional techniques are complementary in non-malignant pain, their role in cancer-related pain is similar. The majority of patients with cancer-related pain can usually be controlled with medical management. However, in certain circumstances medical management will not achieve adequate pain control. Neuroablative procedures and intraspinal delivery of pharmacologic agents are effective measures for patients who have failed conservative management.

Interventional approaches to chronic pain management are continually evolving. In recent years, there has been a growing effort to further study the efficacy and place in therapy of interventional pain management. This is in large part due to the growing body of experiential knowledge in the use of these procedures, but this is not a substitute for well designed trials. A greater understanding of the exact mechanisms of these procedures will also improve our ability to determine their place in clinical practice.
Biography
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Dr. Kucera is the Medical Director of the Pain Medicine department at Stormont-Vail Hospital in Topeka, Kansas. Board certified in anesthesiology, he received his Doctor of Medicine degree at Texas Tech University where he did his residency training and his Doctor of Pharmacy degree at the University of Nebraska Medical Center.

Conflict of Interest Statement
I declare that I have no proprietary, financial, professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled “Interventional Pain Procedures: Understanding their Role in Clinical Practice.”

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