Review Article

Interventional Management of Chronic Pain

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Abstract

Chronic non-cancer pain is a common clinical condition affecting a significant part of the population. This article aims to review the interventional options for non-cancer pain. Multiple searches using Medline were carried out and additional searches were made using reference lists of published papers and book chapters. The article discussed procedures ranging from selective nerve root or zygapophyseal (facet) joint block with local anaesthetics to irreversible neurodestruction with radiofrequency energy or neurolytic agents and neuromodulation with spinal cord stimulation. Other techniques include intraspinal delivery of analgesics. There is evidence that these interventional procedures are valuable both diagnostically and therapeutically.

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Introduction

Chronic non-cancer pain is a common clinical condition afflicting 15% (2% to 40%) of the population[1] with 13% of them experiencing some form of functional disability.[2] It represents a significant drain on the physical, emotional and social state of the individual as well as an economic burden to the healthcare system. In 1998 alone, the United States of America spent US$90 billion to treat chronic non-cancer back pain and it was estimated that expenditure for this disease entity was 60% higher than what was spent to treat coronary artery disease and the acquired immunodeficiency syndrome (AIDS) combined.[3]

Pain is an unpleasant sensation triggered in the nervous system to alert or caution the human body of impending or actual ongoing damage that endures and persists beyond the term of injury.[1] It can occur in any part of the body-back, neck or head. It can be categorised into spinal or non-spinal causes, and may be somatic or neuropathic in origin. The causes of chronic non-cancer pain are so diverse that it encompasses almost all aspects of medicine including trauma, musculoskeletal, neurological, vascular and degenerative diseases. With the multitude of aetiologies, it is not surprising that chronic non-cancer pain management continues to be a challenging and evolving field.

The World Health Organisation (WHO) has produced an analgesic ladder to be used as a guide for prescribing analgesics. Although originally produced for cancer pain, it has been increasingly used as a guide for chronic persistent non-cancer pain. Oral analgesics are considered first-line therapy and progression to the next step using stronger analgesics when pain control is not optimised. However, when pharmacological therapy or conventional surgery fails to control pain, the role of minimally invasive interventional procedures remain an option for the treatment of chronic pain. It is considered when drug therapy provides inadequate pain relief or when patients have intolerable side effects to drug treatment. Interventional procedures target the neural structures that are presumed to mediate the experience of pain. Procedures can range from reversible blockade with local anaesthetics such as selective nerve root or zygapophyseal (facet) joint block, irreversible neurodestruction with radiofrequency (RF) energy or neurolytic agents, to neuromodulation with spinal cord stimulation (SCS). Other techniques include intraspinal delivery of analgesics.

Patient Assessment and Selection

The success of any intervention begins with proper patient evaluation and selection, taking into consideration the patient's unique presentation of symptoms and overall health status. It is important to weigh the risks and benefits of performing an interventional procedure.

Patient assessment begins with an accurate history and a focused physical examination. Malignancy, infection and fractures are some of the ''red flags'' that must be ruled out prior to the formulation and recommendation of treatment

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strategy. The role of diagnostics in chronic non-cancer pain management cannot be overemphasised. Magnetic resonance imaging (MRI) is the single most sensitive and most specific investigation to reveal conditions such as disc herniation, soft-tissue or neurological lesion, neoplasm or infection. Other tests ranging from plain film radiography to computed tomography (CT) scan can also be considered.[4] Together, both clinical and objective diagnostics provide a more reliable assessment of the pain problem.

Pharmacological Intervention

Drugs commonly used for interventional procedures include corticosteroids, local anaesthetics (lignocaine and bupivacaine), alcohol or phenol. Steroids relieve pain by reducing inflammation, blocking transmission of nociceptive C-fibre input and inhibiting the action of phospholipase A2, both responsible for cell membrane injury and oedema.[5,6] Due to the risk of complications associated with prolonged use, corticosteroids for interventional procedures are administered not more than 3 to 4 times a year.[2] Local anaesthetics are used to confirm appropriate medication delivery and to provide temporary relief until the corticosteroids reach their therapeutic levels.[7]

Alcohol and phenol are nerve protein denaturation agents that act as neurolytics by destroying neural structures involved in the perception of pain. They promote a longer lasting analgesia by interrupting nociceptive transmission from the peripheral tissues to the spinal cord. Diagnostic blocks using local anaesthetics are usually performed first before proceeding with chemical neurolysis.[7]

Non-pharmacological Intervention

A non-pharmacological intervention that is frequently advocated is RF lesioning of nerves or ganglion. RF is a neurodestructive technique that uses continuous heat to produce controlled tissue destruction (thermocoagulation), thereby modulating pain transmission without causing clinical signs of nerve damage. Although pain relief is also temporary due to axon regeneration, multiple controlled trials have shown strong evidence in providing lasting relief for facet joint pain.[8]

Spinal Pain

Nociception emanating from the cervical, thoracic and lumbosacral regions constitutes the majority of the problems and falls under the category of spinal pain. It is estimated that the lifetime prevalence of persistent and frequent lower back (lumbar) pain is 50% to 80% in the American population.[9] It is also the most common reason for limitation of activity in the younger population and is the most frequent cause of absence from work.[9] The prevalence of neck (cervical) pain is lower and is estimated to be 40% among the working population, 10% to 37% of which will develop chronic symptoms.[9] In contrast, the epidemiological data shows that the thoracic portion is less commonly involved than the other regions of the spine. Linton et al estimated the prevalence of spinal pain in the general population as 66% – among them 15% reporting thoracic pain, in comparison to 44% and 56% for cervical and lumbar regions, respectively.[2,10] Pain is caused by pathological alterations in the vertebrae, intervertebral discs, spinal cord, nerve roots, facet joints, ligaments or muscles.[2]

Zygapophyseal (Facet) Joint Injection

Facet joints have been implicated in 15% to 45% of patients with back pain and 54% to 60% of patients with neck pain.[1,11,12] Pain is usually described as dull, stiff or achy and is exacerbated by movements that compress the joints (extension). Pain in the lumbar facet joints usually radiates to the buttocks and upper posterior thigh, while cervical facet joint pain presents with headache, shoulder or mid-back pain. However, the location of referred pain cannot be used reliably to infer the exact spinal level where the pathology is. Furthermore, facet joint pain cannot be diagnosed by clinical examination or by imaging studies consistently.

Injection of local anaesthetic into a facet joint can aid the clinician in determining the source of pain.[2,13] Deriving at least 50% pain relief after injection is considered a true positive. Corticosteroids may also be added to reduce inflammation and they act by inhibiting synthesis or release of pro-inflammatory substances.[2,14] The actions of local anaesthetics and corticosteroids are synergistic and additive, yielding immediate as well as long-term effects. Local anaesthetics confirm the source of pain and provide temporary relief, allowing corticosteroids to reach therapeutic level after 24 to 48 hours of the intervention. Following a single intra-articular injection, there is short-term relief (less than 6 weeks) in 46% to 75% of patients while long-term relief (6 weeks or longer) is seen in 20% to 36% of the patients.[8] Thus, this intervention is both practical and cost-efficient as it is diagnostic as well as therapeutic.

Results from clinical trials differ but all show a similar pattern of response and outcome. A study done by Manchikanti et al[15] showed significant pain relief with 1 to 3 lumbar medial branch blocks of local anaesthetic and methylprednisolone in all patients for 1 to 3 months, 82% of the patients for 4 to 6 months, and 21% for 7 to 12 months. The mean duration of pain relief was 6.5 months. In another study by the same author, significant pain relief (improvement more than or equal to 50%) was exhibited at 3, 6 and 12 months in 80% to 87%, 80% to 93%, and 87% to 93% of patients after cervical medial branch block,

respectively.[16]

Combined intra-articular local anaesthetic and steroid injection, unfortunately, does not appear to be equally efficacious in all spinal areas and some differences in efficacy can be expected. The majority of studies provide evidence of short- and long-term relief mainly in the management of neck pain.[17] For lower back pain, evidence is only moderate.[18] However, studies involving both the cervical and lumbar regions demonstrate significant improvement in overall functional status, psychological status and employment eligibility within 12 months of treatment.[15,17]

The benefits of interventional pain strategies are attractive for any symptomatic patient but one must be wary of the potential risks and complications of any procedure. Most problems are related to needle placement and include haemorrhage, haematoma formation, dural puncture, spinal cord and nerve trauma that can lead to paralysis. Infection, intravascular injection, pneumothorax, radiation exposure, facet capsule rupture and intrathecal or epidural spread may also occur. Drug administration may also be responsible for some complications and these include chemical meningitis and steroid side effects. All these adverse effects, however, are rare and often minor.[1,2,19]

One drawback of intra-articular facet joint injections or medial branch nerve blocks is that pain relief is not permanent. As such, denervation of the facet joint may be offered to prolong the analgesic effect and this is achieved by RF thermoablation – a neurodestructive process that involves heating and eventual destruction of nerves supplying the joint. However, it is prudent to bear in mind that the duration of pain relief is only extended and not lifelong. RF neurotomy of lumbar and cervical medial branches demonstrated strong and moderate evidence for short- and long-term relief, respectively.[1] However, pain eventually returned due to some regenerative activity but in these cases, a repeat neurotomy could be offered. Complications of RF neurotomy include cutaneous hyperaesthesia or dysaesthesia, neuritis, neurogenic inflammation, anaesthesia dolorosa and deafferentation pain. Excessive burning of tissue outside the target area may also cause escalation of pain.[20,21]

Sacroiliac Joint Injection

The sacroiliac (SI) joint receives its innervation from lumbosacral roots and as such, is responsible for pain in 10% to 30% of patients with chronic lower back pain.[12] This diarthrodial joint can produce pain that radiates to the thigh, lower extremity, groin and occasionally, abdomen. Although it does not fall under the category of spinal pain, SI joint pain is uniquely managed in a similar fashion. Improvement after intra-articular injections has been reported in 62% of patients at 3 months and 58% at 6 months.[22] SI joint injection is moderately accurate in clinching the diagnosis.[23] When performed in conjunction with pain provocation tests (distraction, thigh thrust, right- and left-sided Gaenslen's test, compression and sacral thrust tests), a sensitivity of 94% and specificity of 78% is reached.[24,25] The relatively higher sensitivity may be due to extravasation of anaesthetic agents from the joint into the adjacent capsule producing a more diffuse anaesthetised area.[26] On the other hand, the lower specificity may be due to technical difficulties and anatomic limitations. Complications are rare and include infection, sciatic nerve trauma, embolic phenomena, and other problems arising from drug administration such as epidural spread and foraminal filling.[1]

Numerous studies have also shown that percutaneous RF neurotomy of SI joints provide long-term relief.[27] RF lesioning produces 50% relief in 89% of patients for at least 6 to 9 months.[26,28] Complications are infrequent and the most common is neuritis, which occurs in less than 5% of patients.[21]

Transforaminal Epidural Steroid Injection

Transforaminal epidural or selective nerve root blocks using local anaesthetic can be used to confirm the source of radicular pain in 45% to 100% of cases, especially when imaging studies suggest multiple nerve root involvement.[29] When combined with steroids, such interventions are therapeutic as well with significant relief lasting for 2 months or more in 30% of patients with reports of improvement in functional ability in 75% of patients.[30] The majority of studies report strong evidence for short-term and moderate for long-term improvement in managing lumbar and cervical nerve root pain.[8]

Neuropathic Pain

When pain results from nerve injury or dysfunction, it is known as neuropathic pain.[31] Neurogenic causes account for 20% of pain complaints in chronic pain patients.[12,32,33] Pain may be described as constant, burning, intense and shock-like, which can occur spontaneously or be evoked by movement and touch. Features of allodynia and hyperalgesia are frequently present. However, all these features do not confirm a diagnosis of neuropathic pain.[31]

Neuropathic pain conditions include trigeminal neuralgia, chronic post-surgical pain, peripheral nerve impingement syndromes, post-herpetic neuralgia, complex regional pain syndrome, and phantom limb pain.[2] Sympathetic blockade with local anaesthetic as well as RF neurotomy have been shown to provide pain relief.[34,35]

Stellate Ganglion Block

Stellate ganglion block is indicated for pain in the head, neck and upper limbs, which is suspected to be mediated

sympathetically. Although Horner's syndrome (ptosis, miosis, enophthalmos, facial anhydrosis) is witnessed in up to 87% of patients,[36] the development of pain relief is still the most reliable in determining whether the block is effective. Complications, although rare, include accidental intravascular and intrathecal injection, resulting in convulsion and high spinal block, respectively. Other complications include pneumothorax, and blockade of the phrenic, recurrent laryngeal and brachial plexus nerves.[34]

Lumbar Sympathetic Block

Lumbar sympathetic block is effective in 48% to 80% of patients with pain involving the lower extremities.[36,37] Some of these conditions include complex regional pain syndrome, ischaemic pain and painful diabetic neuropathy. One of the possible complications is genitofemoral neuralgia, which occurs in 5% to 20% of patients.[37-39] Other complications include transient post-sympathectomy neuropathic pain in the anterolateral proximal lower limb, damage to the kidney and ureter, and ejaculatory failure. These complications are seen more commonly after neurolytic blockade.[39]

Superior Hypogastric Plexus Block

Although there is currently no literature available reporting its efficacy for pelvic non-cancer pain, superior hypogastric block has been done as a prognostic and therapeutic block using neurolytics or RF for endometriosis, pelvic inflammatory diseases and adhesion pain.[39] The risk of vascular puncture due to the close proximity of the bifurcation of the common iliac vessels leading to subsequent haemorrhage and haematoma formation should be explained. Other complications such as subarachnoid and epidural injection, nerve injury, renal and ureteric puncture may occur but are less likely.[39]

Gasserian Ganglion Block

Trigeminal neuralgia is another common cause of neuropathic non-spinal pain with approximately 15,000 newly diagnosed cases each year.[40,41] Denervation of the Gasserian ganglion with either RF lesioning or glycerol is effective in up to 90% of individuals, and 50% of patients may experience pain relief within 24 hours.[42] Pain relief can last up to 1 to 2 years.[42] Although denervation can lead to significant improvement, there is still a rare possibility of dysaesthesia, corneal sensory loss and anaesthesia dolorosa. Major complications include intracranial haemorrhage, stroke and infection.[40,43]

Intrathecal Drug Delivery

A unique and practical form of management for both neuropathic and non-neuropathic pain involves administration of analgesics intrathecally. Although commonly used for cancer pain, it is also an alternative for non-cancer pain that is not controlled by oral, transdermal, subcutaneous or intravenous routes due to intolerable side-effects such as confusion and nausea.[44]

Drugs used for intrathecal delivery include opioids, clonidine and local anaesthetics. Opioids administered in the intrathecal space modulate pain transmission by its agonistic action on receptors in the dorsal horn of the spinal cord (laminae I, II, V and X). The opioid receptors help suppress afferent nociceptive input from pain sites and suppress postsynaptic excitability of second-order neurons at the level of the spinal cord. Clonidine, on the other hand, binds to postsynaptic alpha-2 receptors within the dorsal horn and activates the descending noradrenergic inhibitory systems.[44] Local anaesthetics administered in the intrathecal space have a synergistic effect when combined with opioids.

Evidence for implantable intrathecal drug delivery system is strong for short-term improvement in neuropathic pain and moderate for long-term management of chronic pain.[1,45] Implantation of a intrathecal catheter system requires surgical expertise and meticulous technique, strong family support and round-the-clock medical support, as well as regular follow-up for pump refills and monitoring. These should all be considered prior to implantation.

The intrathecal morphine is administered using a continuous analgesic delivery (CAD) pump. The dose of morphine administered intrathecally is 100 times less than the intravenous route which provides lower risk of the opioid-induced side-effects such as nausea, sedation, urinary retention, pruritus and respiratory depression. The dose of intrathecal morphine is subsequently titrated to control the pain during this test phase, which could take up to 2 weeks.[46]

Complications can either be device- or drug-related or both. Device-related complications include wound infection or catheter breakage/migration. Drug-related complications include dosing/programming errors, mis-filling, and the spectrum of opioid-related side effects, including nausea, sedation, urinary retention, pruritus and respiratory depression. These side effects are minimised through patient monitoring and careful dose adjustments, and double checking the settings before the patient's departure from the clinic. In general, in a stable patient who begins to have side effects shortly after the pump refill, the programming should be promptly double-checked. A rare complication is granuloma formation at the catheter tip. This is believed to result from high concentrations of opioids used; especially a morphine dose of more than 10 mg/day. A high index of suspicion is indicated in patients presenting with new pain in their back or legs or at the dermatomal level of the catheter tip. Some granulomas are large enough to cause spinal cord compression and neurological dysfunction

such as urinary incontinence, paraparesis or paraplegia.[47]

Spinal Cord Stimulation

Another implantation device called the spinal cord stimulator (sometimes called a generator or pacemaker for pain) is used to deliver mild electrical pulses directly to the spinal cord or nerve fibres. This stimulation interrupts pain messages from travelling to the brain. Patients report a pleasant numbing sensation in the previously painful part of their body. It is indicated when other less invasive pain management options have been exhausted.[45] Painful conditions that will respond to SCS include failed back surgery syndrome, complex regional pain syndrome, severe ischaemic limb pain secondary to peripheral vascular disease, peripheral neuropathic pain and refractory angina.[45,49] Evidence for SCS in failed back surgery syndrome and complex regional pain syndrome is strong for short-term relief (less than 1 year) and moderate for long-term relief (more than 1 year).[1,48-52] Complications with SCS range from infection, haematoma, nerve damage, lack of appropriate paraesthesia coverage, paralysis and nerve injury.[1,53]

Conclusion

Non-cancer pain can arise from pathology of the facet joints, sacroiliac joints, nerve roots of the spine as well as dysfunction of the sympathetic nervous system. The various interventional pain management procedures have been discussed. There is evidence that these interventional procedures are valuable both diagnostically and therapeutically. They are especially beneficial for patients who have contraindications for or refuse surgery or who have poorly controlled pain despite optimising pharmacotherapy. However, interventional procedures carry some risk. These can be avoided by comprehensive evaluation for patient suitability for the procedure, a thorough discussion with the patient regarding the benefits, risks and complications as well as proper surgical technique.

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