Chronic peripheral nerve hyperalgesia in the thoracolumbar region

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ABSTRACT

Chronic neuropathic pain presents a significant burden to health care worldwide. Its complexity and variation in presentation make therapeutic targeting a challenge in clinical practice. We present a case of chronic idiopathic peripheral neuropathy localized to a specific region in the back to highlight current understandings and available treatment options for neuropathic pain.

KEYWORDS Chronic pain; neurectomy; neuropathic pain; peripheral nerve; peripheral neuropathy

Chronic pain presents a significant burden in global health care. A report in 2011 estimated that over 100 million American adults experience chronic pain. The cost to society is up to \$635 billion annually in medical treatment and lost productivity.^{1,2} Neuropathic pain (NP) of the peripheral nerves is of particular interest. The International Association for the Study of Pain defined NP as pain caused by a primary lesion or dysfunction in the central or peripheral somatosensory nervous system.³ It is characterized by allodynia, hyperalgesia, and spontaneous pain without stimuli.⁴ Heterogeneity in etiology and differences in patient presentation blur clinical recognition and diagnosis of NP. Several studies place prevalence rates between 6% and 8%, which falls within the global estimated range of 0.9% to 17.9%.^{1,5} We describe a peculiar case of chronic idiopathic peripheral neuropathy in a middle-aged man localized to a specific region.

CASE DESCRIPTION

A 42-year-old man with a 19-year history of chronic focal hypersensitivity and hyperalgesia with accompanying numbness and tingling at the right T12 to L1 region presented for neurosurgical evaluation. Previous trials of conservative management, including physical therapy, nonsteroidal anti-

inflammatory drugs, muscle relaxants, narcotics, and corticosteroid injections, provided minimal to no relief. Hematologic and basic chemistry levels were unremarkable. Recent magnetic resonance imaging of the thoracolumbar spine was remarkable only for age-related disc degeneration (*Figure 1d*). No underlying subcutaneous mass or neoplasms was observed. A neuroma was suspected and the patient underwent exploration of his posterior right T12 to L1 subcutaneous area. Intraoperative images showed abnormal subcutaneous material with inflamed subcutaneous nerves deep to overlying scar tissue (*Figures 1a, 1b*). A neurectomy was performed with the nerves and surrounding tissue specimens collected. Microscopic evaluation of the specimens was performed (*Figure 1c*). Both specimens were negative for neoplasms. Two-week postsurgical follow-up was unremarkable. The patient noted only mild incisional pain at 3/10 on the pain scale.

DISCUSSION

Extensive research has been done in an attempt to unlock the neurophysiology of pain. Pain is classified in two broad categories: nociceptive and neuropathic (*Figure 2*), with the major difference between the two being the absence of continuous noxious (mechanical, thermal, or chemical) stimuli

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Figure 1. Intraoperative image showing (a) benign soft subcutaneous scar tissue with focal hemorrhage and (b) peripheral nerve deep to scar tissue. (c) Microscopic image of resected peripheral nerve showing benign nerve fibers with degenerative changes and Schwann cell proliferations (100 $\times$). (d) Preoperative T1 sagittal magnetic resonance image of the thoracolumbar region.

Figure 2. Simple Venn diagram illustrating the differences in nociceptive vs neuropathic pain. Overlapping of both produces a mixed-type pain caused by both direct nerve injury and secondary effects.

in NP.³ Nociceptive pain is well understood. On the other hand, the neurophysiology of NP remains poorly comprehended. The differences in types of nerve injury make it difficult to pinpoint its exact mechanism. Central to studies on NP is the role of inflammatory mediators in the activation, excitation, and sensitization of nociceptive receptors to innocuous stimuli.^{2,6–8} Extensive molecular, cellular, and electrophysiological changes throughout the primary sensory neuron following peripheral nervous system injury contribute to central sensitization and development of persistent NP.⁷

Many theories have been proposed to explain the maladaptive changes causing hypersensitivity and hyperexcitability of peripheral neurons. One emerging theory by Carrasco et al links NP to central sensitization as a result of mitochondrial dysfunction induced by oxidative stress following peripheral

Table 1. Therapeutic models in neuropathic pain

Management	Types
Conservative	<p><i>Pharmacologic:</i> nonsteroidal anti-inflammatory drugs, acetaminophen, antidepressants, antiepileptics, opioids, tramadol, local anesthetics, nerve blocks, corticosteroid injections</p> <p><i>Nonpharmacologic:</i> adjuncts (acupuncture, acupressure, chiropractic massage), nutrition, cognitive-behavioral therapy/biofeedback, physical or occupational therapy</p>
Surgical	<p><i>Neuromodulation:</i> spinal cord stimulation, peripheral nerve stimulation/peripheral nerve field stimulation, deep brain stimulation, transcutaneous electrical nerve stimulation, transcranial direct current stimulation</p> <p><i>Nerve-related therapeutic procedures:</i> neurolysis, decompression, neurectomy, nerve repair, rhizotomy</p>
Miscellaneous	Botulinum toxin, percutaneous cryoablation, radiofrequency thermoablation, pulsed radiofrequency, stem cell therapy, capsaicin

nervous system injury. Their study implicates reactive oxygen species as a contributor to glial activation, structural damage, decreased antioxidant defenses, and activation of inflammatory response in nervous tissue.^{2,6} This theory is consistent with studies that report the analgesic effects of reactive oxygen species scavengers on NP.^{6,9} Other studies have proposed that intact nerve fibers adjacent to injured nerves may be the culprits of pain generation via Wallerian mechanisms.¹⁰

A multimodal approach to treatment of chronic NP has been adopted. This has been more evident in patients with comorbid medical conditions.¹¹ The approach involves the use of both conservative and surgical management of NP (Table 1). Conservative strategies include pharmacologic and nonpharmacologic techniques in the management of NP. Pharmacologic therapy has been shown to provide only partial relief in 40% to 60% of patients.² More studies are being conducted to identify more effective potential targets in the neurophysiology of NP. Many of the targets studied are located in the dorsal root ganglion (DRG). Several therapeutic approaches have been proposed that target the DRG, including nerve blockade, electrical stimulation, and gene therapy.¹²

Surgical management of NP includes neuromodulation and nerve-related procedures. Advances in the field of neuromodulation have made it an attractive and effective option in the management of chronic pain syndromes. Various methods of neuromodulation exist. It has been hypothesized that electrical stimulation in the peripheral nervous system may alter neurotransmitters, local inflammatory mediators, and ectopic discharges of damaged neurons, leading to inhibition of pain transmission.¹⁰ This is evident in recent studies involving DRG stimulation. Though largely unclear, proposed mechanisms of action in DRG stimulation include upstream vasodilatory effects, deactivation of sensitized wide-

Table 2. Patient characteristics, procedures, and outcomes following peripheral neurectomies

Case	Age/sex	Pathology	Procedure performed	Prior treatments	Pain duration	Result	Follow-up
Souza et al ¹⁴	43/F	RUQ abdominal pain after laparoscopic cholecystectomy	Patient-guided peripheral nerve neurectomy	Gabapentin, amitriptyline, narcotics, local anesthetics	3 years	Minimal-intermittent pain; acetaminophen	10 months
Souza et al ¹⁴	59/M	Traumatic neuroma in left first web space	Neurectomy of deep peroneal nerve	NA	18 months	Immediate relief	11 months
Adkinson et al ¹⁵	36/F	Right breast myospasms	Bilateral medial and pectoral nerve neurectomy	Botox, narcotics, muscle relaxants	NA	Immediate relief	9 months
De Ruiter et al ¹⁶	65/M	Right meralgia paresthetica	Resection of right lateral cutaneous nerve	Previous bilateral neurexeresis	22 months	Immediate relief	2 years
Heare et al ¹⁷	43/F	Left leg saphenous neuralgia	Saphenous nerve neurolysis and neurectomy	Desensitization therapy, removal of tibial screw	~3 months	Immediate relief	6 months
Salzman et al ¹⁸	39/F	Superior laryngeal neuralgia	Bilateral surgical SL neuralgia	Radiofrequency SL neurectomy, radiosurgery	5 years	Immediate relief	14 months
Boelens et al ¹⁹	36/F	Posterior cutaneous nerve entrapment syndrome	Resection of 12th intercostal nerve	Pain management	NA	Minimal discomfort	2 years
Present case	42/M	Idiopathic subcutaneous neuralgia	Neurectomy of T12–L1 subcutaneous nerve	PT, NSAIDs, narcotics, and corticosteroid injections	19 years	Mild pain with “inflamed” sensation	2 months

NA indicates not available; NSAIDs, nonsteroidal anti-inflammatory drugs; PT, physical therapy; RUQ, right upper quadrant; SL, superior laryngeal.

dynamic-range neurons within the dorsal horn downstream, and modulation of supraspinal brain regions involved in the development and maintenance of chronic pain.¹³

Nerve-related surgical procedures such as decompression/neurolysis, neurectomy, and nerve repair/reconstruction offer another approach to NP management.⁵ These are often the last line of treatment following failure of other therapeutic modalities. Decompression of single nerve fibers is beneficial overall in the reduction or treatment of peripheral neuropathy. Neurectomies have shown variable response, because they are largely patient dependent and case specific.⁵ Literature review of case studies within the past 5 years has shown neurectomies to be effective in treating various peripheral neuralgias (Table 2).^{14–19}

The use of surgical techniques in managing NP is largely physician dependent. Consensus indicates surgical evaluation with failure of conservative management. However, the preference for neuromodulation versus nerve-related surgical procedures remains up for debate. Factors including etiology of NP, case presentation, location of pain, physician experience, and patient preference play a role in the choice of treatment. There is a paucity of studies available comparing the effectiveness of the treatment options. Future studies may offer some insight into targeted chronic NP management.

As in our case, idiopathic peripheral neuropathy can be a chronic debilitating issue affecting patient quality of life. Without definitive diagnosis, multimodal therapeutic—especially pharmacologic—options may be limited. It may be prudent to explore neurosurgical treatment in patients experiencing chronic neuropathic pain with unknown underlying pathology.

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