

Surgical Management of Painful Diabetic Peripheral Neuropathy: A Focused Review

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Abstract

Peripheral diabetic neuropathy (PDN) is one of the major complications arising in patients with diabetes. A triad of metabolic abnormalities is known that render the peripheral nerve in diabetes mellitus susceptible to chronic compression: conversion of glucose to sorbitol increases the intraneural water content, slowing of axoplasmic transport of proteins hinders structural repair, glycosylation of endoneurial collagen reduces perineurial gliding. Due to connective tissue fibrosis, impaired microcirculation, and impaired endoneurial oxygenation, diabetic peripheral nerves are more at risk for entrapment neuropathies both focally and diffusely. Surgical release and decompression was shown to be effective in many entrapment neuropathies but not in diabetes, hence there is a dearth need to evaluate the current evidence on surgical decompression's effectiveness in diabetic peripheral neuropathy (DPN). The objective of this review is to provide an evidence-informed update on the effects, efficacy and effectiveness of surgical treatments in patients with painful diabetic peripheral neuropathy (PDPN). MEDLINE was searched for articles and 23 studies were obtained and a descriptive review found that surgical decompression of superimposed nerve compressions in the patient with symptomatic neuropathy reliably relieves pain, restores sensation, and thereby prevents ulceration and amputation. Surgical decompression is thus an established critical, practical and a successful treatment option for patients with PDPN.

Keywords: Diabetic peripheral neuropathy; Decompressive surgery; Operative management.

Introduction

Peripheral diabetic neuropathy (PDN) is one of the major complications arising in patients with diabetes. Since PDN is traditionally considered an irreversible disorder, treatment has been aimed to prevent the development of complications. In a novel concept, however, it is postulated that decompression surgery of

the affected nerve may reverse the natural course of PDN[1]. A triad of metabolic abnormalities is known that render the peripheral nerve in diabetes mellitus susceptible to chronic compression: conversion of glucose to sorbitol increases the intraneural water content, slowing of axoplasmic transport of proteins hinders structural repair, glycosylation of endoneurial collagen reduces perineurial gliding[2].

Entrapment neuropathies occur due to compression of peripheral nerves in a narrow tunnel or space secondary to Intraneural or extraneural causes. The Intraneural causes include: neural inflammation and edema, nerve sheath tumors and the extraneural causes include compression from other adjacent structures[3]. Although carpal tunnel syndrome[4] is the most common entrapment

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neuropathy in the human body, peripheral nerves of both upper[5] and lower limbs[6] are susceptible to compression either at a single site or multiple sites such as 'crush syndromes'. Due to connective tissue fibrosis, impaired microcirculation, and impaired endoneurial oxygenation, diabetic peripheral nerves are more at risk for entrapment neuropathies both focally and diffusely[7].

Surgical release and decompression was shown to be effective in many entrapment neuropathies but not in diabetes, hence there is a dearth need to evaluate the current evidence on surgical decompression's effectiveness in diabetic peripheral neuropathy (DPN). The objective of this review is to provide and evidence-informed update on the effects, efficacy and effectiveness of surgical treatments in patients with painful diabetic peripheral neuropathy (PDPN).

Materials and methods

A systematic review and search with (Surgical OR decompression) AND (diabetic OR diabetes) AND (neuropathy OR neuropathic) IN [Title] was used for searching the MEDLINE for all articles published in English. The testers conducted independent search and disagreements were solved through consensus. The selected studies were scrutinized and were organized under four distinct themes (experimental studies, pain, neurological function, foot deformities and autonomic dysfunction).

Main findings

In total, there were 23 studies that were included which are summarized as follows;

Surgical management in animal studies (experimental models)

In a study by Kale et al[8], the right sciatic nerves of 30 rats with streptozotocin-induced diabetes were used; three groups were created. In the control group, the sciatic nerves were

explored and dissected only. In group II, tarsal tunnel release was performed and accompanied by epineurotomy of the sciatic nerve and its peroneal and tibial extensions. In group III, in addition to the procedures performed in group II, perineural sheaths, exposed through the epineurotomy sites at both the peroneal and tibial nerves, were incised for decompression of the fascicles. Improvement in diabetic neuropathy was evaluated by using footprint parameters, and the authors found that adding internal decompression to external release doubled the effect in reducing derangement in the sciatic nerves of the rats.

Surgical management for pain in PDPN

Karagoz et al[9] performed surgical decompression of common peroneal, posterior tibial and deep peroneal nerves in 24 patients and found that pain relief rate was 80% at postoperative first day and 85% at 6 months postoperatively on follow-up.

Rader[10] performed external and as-needed internal neurolysis of the common peroneal, deep peroneal, tibial, medial plantar, lateral plantar, and calcaneal nerves, and found greater improvements in subjective pain perception and objective sensibility functions in patients with PDPN secondary to both type-1 and type-2 diabetes.

Surgical management for neurophysiological function in PDPN

Karagoz et al[9] performed surgical decompression of common peroneal, posterior tibial and deep peroneal nerves in 24 patients and found that 2-point discrimination was improved 72.6% on first post-operative day and 89% at 6-months follow-up.

Siemionow et al[11] in their retrospective review of 32 patients (diabetic and non-diabetic peripheral neuropathy) who underwent 36 surgeries where 99 lower extremity nerves were surgically decompressed, and they found that there were

improvements in muscle function, 2-point discrimination, pain and function.

Wood and Wood[12] found that short-term results in 33 lower extremities of type-1 and type-2 diabetic patients were good to excellent in 90.0% of those patients with preoperative neuropathic pain, and restored sensation at good to excellent levels in 66.7% of those patients with preoperative neuropathic numbness. The authors suggested that external neurolysis of the common peroneal, deep peroneal, and tarsal tunnel nerves in selected patients with symptomatic diabetic neuropathy and an overlying compression neuropathy as determined by using computer-assisted neurosensory testing appears to be an effective treatment for providing pain relief and restoration of sensation in the foot.

Hollis Caffee[13] in a series of 58 operations on 36 patients who were performed for decompression of the posterior tibial nerve found that the operation was effective for relief of pain in 24 of the 28 patients with that complaint (86 %). Restoration of sensation was less consistent with improvement noted in 18 of the 36 patients (50 %).

Dellon¹⁴ in a prospective study from 1982 to 1988 in which diabetics (38 type I, 22 type II) had surgical decompression of 154 peripheral nerves in 51 upper extremities and 31 lower extremities. Mean postoperative follow-up was 30 months (range 6 to 83 months). Considering the entire series, an excellent final result was noted for motor function in 44 percent and for sensory function in 67 percent of the decompressed nerves. Ten percent of the patients were not improved, and 2 percent were worse in sensorimotor function. Upper extremity nerve decompressions achieved better results than lower extremity nerve decompressions.

Surgical management for natural progression of PDPN

Aszmann et al[15] in their retrospective review of 50 patients found that no ulcers or amputations occurred in the index limb of these patients. In contrast, there were 12 ulcers

and 3 amputations in 15 different patients in contralateral limbs. Thus the natural history of diabetes neuropathy which is progressive and irreversible loss of sensibility in the feet, leading to ulceration and/or amputation was changed by surgery.

Surgical management for foot deformities in PDPN

Assalet et al[16] performed reconstructive surgery on fifteen adults with diabetes mellitus who had a severe neuropathic midfoot deformity consisting of a collapsed plantar arch with a rocker-bottom foot deformity. The authors performed surgical realignment and arthrodesis with a medial column screw and they reported benefits of improved walking and reduced ulcers though complication of non-union occurred in a few.

Surgical management for autonomic neuropathy in PDPN

Guy et al[17] reported two cases with intractable vomiting due to gastroparesis, a rare feature of diabetic autonomic neuropathy, are described. Both required surgical treatment. In the first a gastroenterostomy was complicated by reflux gastritis requiring a revision operation; in the second a gastrojejunostomy was successful. Electron microscopic studies of the vagus nerve in one of the cases showed a severe reduction in the density of unmyelinated axons, the surviving axons tending to be of small calibre. The severity of the abnormalities supported the view that diabetic gastroparesis is related to vagal denervation.

Schustek and Jacobs[18] opined that the onset of autonomic neuropathy can often be insidious and may be associated with somatic neuropathy. Whether the autonomic dysfunction has a primary role or simply serves as a marker for other disease processes remains unclear. There is no doubt, however, that autonomic neuropathy, once present, greatly complicates the diabetic state and the management of the diabetic patient in the

perioperative period and also statistically increases the mortality risk.

Discussion

Historically, the existed concepts led to the conclusion that the only role for surgery in a patient with diabetic neuropathy is for treatment of wounds, amputation, or reconstruction of a Charcot foot[19]. Although the role of surgery in PDPN remained controversial[20], our findings are in agreement with Dellon[2] who found that surgical decompression of superimposed nerve compressions in the patient with symptomatic neuropathy reliably relieves pain, restores sensation, and thereby prevents ulceration and amputation. Surgical decompression is thus an established critical, practical and a successful treatment option for patients with PDPN albeit with only a lower (unproven) level of recommendation by the Therapeutics and technology assessment subcommittee of American academy of neurology[21].

The most important implication of this review is that diabetic nerve decompression is not for every patient with PDPN. The clinical features such as: positive Tinel's sign, negative neuropathic signs (sensory, motor and/or reflex deficits), and other compression signs (palpation / digital pressure, positive special tests) should be present in order to derive maximum benefits of surgery[22]. The presence or absence of a positive Tinel's sign is a prognostic indicator for determining outcome for surgical decompression procedures in PDPN with a sensitivity of 88%, a specificity of 50%, and a positive predictive value of 88%[23].

The probable mechanisms for surgical methods' efficacy could be attributed to these findings[24]: 1) that sciatic nerve blood flow in diabetic rats is increased or unchanged in unexposed nerves, while also confirming reports that in surgically exposed nerves blood flow is higher in control than in diabetic rats, and 2) indicate that blood flows in surgically exposed nerves are largely a measure of

vascular responses to injury rather than (patho)physiological blood flow in undisturbed nerves.

There is a need for further research on comparison of different surgical methods, either alone or in combination and/or comparison with medical[25], physiotherapeutic[26] and manual physical therapy interventions[27] in people with PDPN. There is also need for deriving clinical prediction/decision rules utilizing clinical examination findings[28], clinical assessment scales[29] and treatment subgroups' responses in high quality randomized clinical trials of surgical interventions.

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