Brain Stimulation 12 (2019) 792–793

Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: http://www.journals.elsevier.com/brain-stimulation

Case report of the treatment of diabetic foot disease using spinal cord stimulation

Dear Editor:

We report the use of spinal cord stimulation (SCS) to treat diabetic foot disease in three patients. The first subject was a 76-year-old Asian male with diabetic foot disease, cerebral infarction, and right posterior tibial artery occlusion. Risk factors for this patient included histories of both type-2 diabetes and hypertension. The patient experienced pain in the left leg and foot, mild edema in the lower limbs, no numbness, no sensory disturbance, grade 1 muscle strength of the right limb, normal muscle tension in the left limb, and no pathological reflex. These symptoms had become progressively more aggravated over a 2-month period. A localized blackened area of 2×2 cm in size on the right heel had been apparent for 20 days and was accompanied by obvious tenderness. Color Doppler ultrasound indicated a right tibial artery occlusion. After 10 days of treatment with medication, the patient's symptoms had not significantly improved. Therefore, SCS was implemented.

Under local anesthesia, electrodes (model 565 SPECIFY2*8; Medtronic, USA) connected to a temporary stimulator were inserted into the dorsal epidural space of the spinal canal centering on level T11 (Fig. 1) to create numbness through the lower limbs and a feeling of warmth in the area affected by pain. Following a 10-day trial, resulting in excellent pain relief, a permanent stimulator powered by a battery was placed in position. The spinal electrode was connected to the permanent stimulator implanted subcutaneously in the right side of the waist. After another successful trial, the patient showed a marked improvement and continued to respond well to the treatment. The patient then underwent SCS paddle lead placement. On day 1 following surgery, the skin temperature of the patient's left leg was raised and the pain and edema were alleviated. The patient complained of pain in the incisions on the back and waist. The incisions were covered with alginate silver ion dressing and, following removal, fat liquefaction was found here. During day 3, the skin temperature of the patient improved without pain or pitting edema in the lower limbs. The patient was discharged on day 12 following surgery. There were no severe adverse effects during his entire course of treatment. At the final follow-up, the patient reported complete relief of his shank pain and edema, improved walking ability, healing of the right heel (Fig. 1), and improved quality of life. In addition, the percutaneous oxygen partial pressure of his left lower limb increased from 2 to 35 mm Hg and his skin temperature increased by 2 °C (Fig. 1). The patient was aware that the temperature of the skin had increased and the pain was relieved by more than 50%.

Two other patients (Mr. A, a 74-year-old man and Mr. B, a 58-year-old man) with diabetic foot disease were treated with SCS. Mr. A had diagnoses of diabetic foot disease, double lower extremity atherosclerosis with plaques, and necrosis at the left lower extremity. He had pain in his feet and cyanosis and ulceration of the skin of his left foot. His symptoms continued unabated. Mr. B experienced numbness in the lower half of his calves occasionally coupled with pain lasting for about 30 s, which could be alleviated by altering his position. After treatment, symptoms improved for both patients and neither showed any relapse in symptoms at a 3-month follow-up check. Mr. A's necrotic site, however, did not improve. These treatments were approved by an Ethics Committee and consented to by all patients before surgery.

Discussion

To our knowledge, this is the first case report on the treatment of diabetic foot disease using spinal cord stimulation. Diabetic foot disease is a general term for severe lower limb lesions caused by foot trauma and infection due to diabetic peripheral neuropathy and peripheral vascular disease. Common manifestations include foot ulcers and injuries that penetrate the entire skin layer sometimes to the level of the bone and joint. The wound surface extension tends not to heal. The treatment of diabetic foot disease includes the restoration of pulsatile blood flow to the distal extremity, relief of pain, and healing of ulcers and wounds.

SCS is an effective and minimally invasive method designed to treat chronic neuropathic pain by acting on the sympathetic-parasympathetic balance in the nervous system. SCS involves the implantation of electrodes in the epidural space to stimulate sensory fibers and activate cell signaling molecules that in turn cause the release of vasodilatory molecules, a decrease in vascular resistance, and relaxation of smooth muscle cells without open surgery [1,2]. In addition, SCS suppresses sympathetic vasoconstriction and pain transmission to significantly improve pain relief, halts the progression of ulcers, and potentially achieves limb salvage [3].

Thus far, SCS has been used mainly to treat chronic pain and less to benefit lower limb ischemia. In this report, patients with unsatisfactory blood sugar control and high risk factors such as hypertension still achieved surprisingly good results in the treatment of their cases of diabetic foot disease. The main mechanisms by which SCS improves pulsatile blood flow to the distal extremities are as follows. Firstly, electrical stimulation of the spinal cord reduces sympathetic efferent activity to combat peripheral arterial vasoconstriction. Secondly, the spinal cord stimulates retrograde activation of sensory fibers and release of vasodilators, thereby dilating blood vessels.

https://doi.org/10.1016/j.brs.2019.01.014
1935-861X/

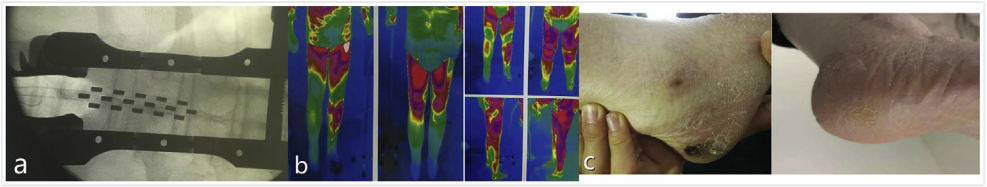

Fig. 1. (a) The contact points of 16 electrodes were inserted into the dorsal epidural space of the spinal canal centering on level T11. The area of electrical stimulation increases with the number of contact points put in place. (b) Comparisons of infrared thermal images taken before surgery and on day 13 following surgery showed that the skin temperature increased. (c) One month after the operation, the patient's heel had completely recovered and normal skin tone was observed.

To summarize, SCS can be used as an effective treatment to relieve lower limb pain, increase pulsatile blood flow to the distal extremities, and partially or proactively preserve limbs that are not completely necrotic, thus reducing the need for amputation. In fact, SCS can be used to relieve phantom limb pain following amputation. SCS has been included in the guidelines as a second-line treatment for lower extremity ischemia. As blood vessels in the lower limbs of diabetic patients present bead-like changes in shape due to the multiple systemic changes associated with diabetes mellitus, the failure rate of intervention therapy, thrombolytic therapy, and vascular reconstruction has greatly increased. Therefore, SCS may be a potential and effective choice at present.

Conflicts of interest

'None' declared by all authors.

References

[1] Epstein LJ, Palmieri M. Managing chronic pain with spinal cord stimulation. Mt Sinai J Med 2012 Jan-Feb;79(1):123–32.
[2] Mekhail NA, Mathews M, Nageeb F, et al. Retrospective review of 707 cases of spinal cord stimulation: indications and complications. Pain Pract 2011 Mar-Apr;11(2):148–53.
[3] Naoum Joseph J, Arbid Elias J. Spinal cord stimulation for chronic limb ischemia. Methodist Debakey Cardiovasc J 2013 Apr-Jun;9(2). 99d com.

Jing-Bo Gao, Min Bao*
Department of Neurosurgery, Shengjing Hospital of China Medical University, Shenyang, China

* Corresponding author.
E-mail address: 13699250880@163.com (M. Bao).

25 December 2018
Available online 28 January 2019