

Technical note

Mesh electrode for peripheral nerve stimulation

Ralph J. Mobbs¹ BSc(MED) MB BS, Peter Blum² MB BS (SYD) FRCS(GLAS) FRACS, Reno Rossato³ MB BS FRACS

¹Peripheral Nerve Research Foundation, Randwick, Sydney, Australia, ²Department of Neurosurgery, Institute of Neurological Sciences, The Prince of Wales Hospital, Sydney, Australia, ³Calvary Hospital, Cairns, Queensland, Australia

Summary The implanted peripheral nerve stimulator has a role for pain relief in well-selected patients with pain in a peripheral nerve distribution. We describe an electrode to help simplify the surgical implantation of a peripheral nerve stimulator and also to reduce the possibility of electrode migration following implantation. Design details of the electrode are discussed, as are notes on surgical technique.

© 2003 Elsevier Science Ltd. All rights reserved.

Keywords: peripheral nerve, electrode, stimulator

INTRODUCTION

Following the gate control theory that stimulation of large diameter afferent fibers can interrupt the transmission of nociceptive input,¹ electrical stimulation of peripheral nerves using implanted and transcutaneous electrodes has been used over the past 40 years.² Wall and Sweet³ first described an implanted peripheral nerve electrode in 1967. The results were mixed with an initial good response followed by a decline. Since then, there has been many reported series in the literature documenting the results of these implantable devices.^{4–6} Initially, circumferential electrodes for treating mononeuropathies were used. These gave way to paddle type electrodes (Resume electrode™, Medtronic, Minneapolis, USA). Difficulty securing these electrodes resulted in electrode migration and failure of the device, both short and long term. The senior author (P.B.) has a series of over 40 implanted peripheral nerve stimulators, larger than any published series. Design modifications discussed here were made with an attempt to improve ease of intraoperative application of the electrode and also to minimize the complication of lead migration.

TECHNICAL NOTE

The modified Resume electrode consists of two design modifications. The first is the unilateral mesh (Fig. 1). The mesh was added to the standard design to help secure the electrode to the nerve requiring stimulation. The mesh is wrapped around the nerve and the addition of a suture(s) to secure the device to adjacent fascia is possible. The second modification is the offset lead. The lead is normally attached to the electrode in the midline on a standard Resume electrode, however, the lead offset helps with “seating” the electrode in the wound as the surgeon can view the lead take-off with the electrode in position.

Implantation of a nerve stimulator is a two-stage procedure. Following confirmation of the nerve to be stimulated, the initial operation involves exposure of a proximal section of the affected nerve under general anesthesia. Positioning of the nerve stimulator should not be over or adjacent to a joint as this may result in failure of the device due to electrode migration with joint movement. Intraoperative direct stimulation of the nerve may be used to

assist anatomical confirmation of the nerve that has been exposed. The segment of nerve exposed should be only enough to apply the stimulator in order to reduce incision size and scar formation. A thin layer of fascia is left over the nerve prior to electrode application. The modified Resume™ electrode is positioned on the deep aspect of the nerve (see Fig. 2). The patient is less likely to notice the device if the firm plate of the electrode is deep to the nerve rather than superficial. The mesh is wrapped around the nerve and secured with a non-absorbable suture in an interrupted fashion; such as 4/0 Nylon (see Fig. 3). The lead offset (Fig. 1) aids in positioning the electrode in the deeper surgical planes. A trial lead is connected to the Resume electrode and exits the skin. The trial generator is attached on day 1 following surgery. A Medtronic representative instructs the patient on the use of the generator so that the patient can find a setting that best suits their pain profile.

Following a trial period of 3–7 days of nerve stimulation, a decision is made in consultation with the patient if the device is to be permanently implanted. As a general rule, for stage 2 to proceed, the patient must have attained at least a 50% reduction in pain scores and have no significant morbidity such as adjacent muscle twitching or lead discomfort. Poor electrode placement can lead to annoying stimulation of adjacent structures and require re-positioning. We do not believe that a trial period of 1–2 days is adequate, as the patient may not yet have returned to full mobility or their usual daily routine. The second stage is performed under general anesthetic. Position of the battery/generator in the chest wall is decided preoperatively in consultation with the patient. Tunneling of a lead from the electrode to the battery/generator is required and performed with a provided tunneling device. Be sure to leave some “slack” in the tunneled lead as the patient may complain of skin tenting and discomfort if the lead is tight. This is most obvious with the upper limb in abduction. During stage 2, we move the arm into a flexed, then an abducted position to assure that the lead does not limit upper limb movement.

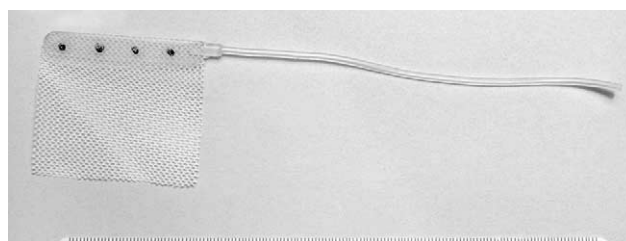


Fig. 1 An early design of the modified Medtronic Resume™ electrode with unilateral mesh and offset lead.

Received 27 August 2002
Accepted 28 October 2002

Correspondence to: R.J. Mobbs BSc(Med), MBBS, 3 Wansey Road, Randwick, NSW 2031, Australia. Tel.: +61-2-9398-7358; Fax: +61-2-9310-0319; E-mail: ralphmobbs@hotmail.com

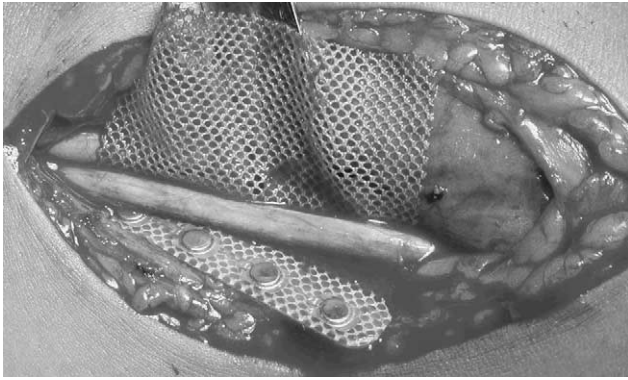


Fig. 2 Modified Resume™ electrode positioned deep to an ulnar nerve prior to wrapping and anchoring by suture.

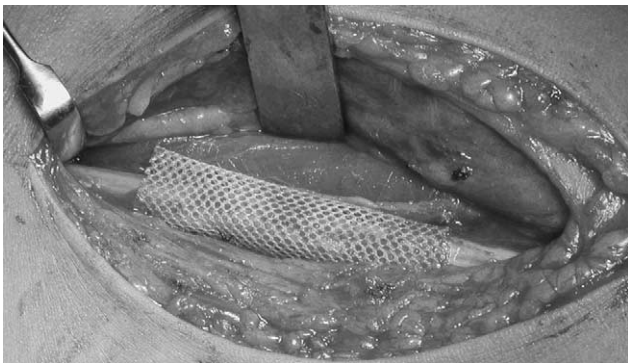


Fig. 3 Mesh around the nerve to secure the electrode and prevent migration.

DISCUSSION

Although there is still debate as to the long-term effectiveness of implantable peripheral nerve stimulators, the authors believe that initial secure and accurate implantation of the electrode is paramount to success. In our own series of 41 long-term implanted stimulators, 8 (19.5%) have required revision due to lead migration or morbidity due to stimulation of adjacent structures. The addition of the modified electrode in the latter part of the study period reduced the frequency of electrode repositioning. The offset lead facilitates implantation, especially if the electrode is positioned deep to the nerve. The mesh fixation reduces the risk of electrode migration due to limb or lead movement. In conclusion, the advantages of the modified electrode are easier surgical implantation and reduced in lead migration.

ACKNOWLEDGEMENTS

We would like to thank Mr. Phil Bragg of Medtronic Australia for providing details of lead development. No grants of any kind were used in the preparation of this article.

REFERENCES

1. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science* 1965; 150: 971.
2. Novak CB, Mackinnon SE. Outcome following implantation of a peripheral nerve stimulator in patients with chronic nerve pain. *Plast Reconstr Surg* 2000; 105(6): 1967–1972.
3. Wall PD, Sweet WH. Temporary abolition of pain in man. *Science* 1967; 155: 108–109.
4. Picaza JA, Cannon BW, Hunter SE, Boyd AS, Guma J, Maurer D. Pain suppression by peripheral nerve stimulation. Part II. Observations with implanted devices. *Surg Neurol* 1975; 4(1): 115–126.
5. Hassenbusch SJ, Stanton-Hicks M, Schoppa D, Walsh JG, Covington EC. Long-term results of peripheral nerve stimulation for reflex sympathetic dystrophy. *J Neurosurg* 1996; 84(3): 415–423.
6. Campbell JN, Long DM. Peripheral nerve stimulation in the treatment of intractable pain. *J Neurosurg* 1976; 45(6): 692–699.