# Intraoperative Nerve Stimulation: A Simple, Effective, and Inexpensive Alternative to Standard Devices

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Many surgical procedures require intraoperative stimulation of peripheral nerves. Using a pair of conventional bipolar forceps and an anesthetic impulse generator (Stimlocator, Model SL3, B. Braun Australia Pty Ltd, Australia), we have developed a simple, effective, and inexpensive alternative to standard nerve stimulation devices that enables the accurate localization of motor fascicles intraoperatively. Bipolar forceps provide better control than a monopolar electrode, as the current generated across the nerve fibers generates an action potential that is then propagated down the axon. This inexpensive and reusable device is routinely used at Royal Children's Hospital, Melbourne, and its efficacy and ease of use has been demonstrated over a long period. (J Hand Surg 2007;xx:xxx. Copyright © 2007 by the American Society for Surgery of the Hand.)

**Key words:** Bipolar nerve stimulation.

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It is sometimes necessary to stimulate nerve fibers in the exploration of multiple nerve bundles (brachial plexus surgery), fascicular orientation (nerve transfer techniques), or exploratory procedures in close proximity to branches of important nerves or where distal motor branches need to be identified in acute trauma (facial nerve). This is usually done by using a commercially available, disposable, monopolar device. Monopolar devices provide a controlled electrical potential at the cathode tip that, when in contact with a nerve bundle, enables current to pass through the body to a circuit-completing anode placed in the adjacent soft tissue. Depolarization, however, is imprecise, as electrons generated by the device may evoke a gross response in the whole nerve bundle. The opportunity to select specific groups of fibers within a nerve trunk is limited. We describe the use of conventional bipolar forceps connected to an electrical impulse generator to directly stimulate across nerve fibers, triggering a more precise and physiological action potential. This allows for more accurate localization of nerve fascicles.

## Technique

Using a pair of conventional bipolar forceps, insulated except at the tips, connected to an anesthetic impulse generator (Stimlocator, Model SL3, B. Braun Australia Pty Ltd, Australia), we have developed an alternative to standard intraoperative nerve stimulation devices. Some bipolar forceps leads can be directly plugged into the current generator; however, single-use leads with terminals molded into a connection plug specifically for electrocautery units (eg, Valleylab, Boulder, CO) are becoming standard in many operating rooms. Cables with alligator clips can be used to establish a connection to the single-use lead (Fig. 1). A current of 0.5 mA delivered with a frequency of 2 impulses per second (2 Hz) will effectively stimulate a normal motor nerve in the absence of muscle relaxant. Scarred and partially functioning nerves sometimes need a current of up to 2 mA to produce a clearly detectable contraction in supplied muscles. F1

Here are some examples of how the nerve stimulator is used at our institution:

(1) Motor fascicles of the ulnar nerve at the mid humerus are suitable for transfer to a paralyzed biceps muscle.[1] These fascicles are contained within that part of the ulnar nerve destined for the flexor carpi ulnaris. The bipolar nerve stimulator assists with precise localization of these fascicles.

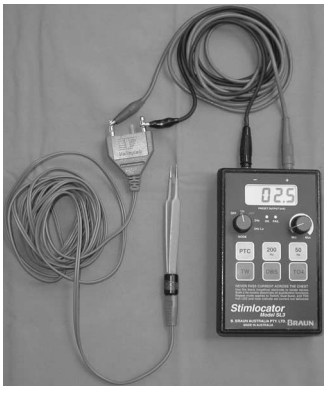


**Figure 1.** Pair of conventional bipolar forceps with single use lead connected with alligator clips to an anesthetic impulse generator (Stimlocator, B. Braun Australia Pty Ltd, Australia).

(2) During the dissection and exploration of the brachial plexus palsy in obstetric palsy, bipolar stimulation of the nerve roots leading to and from an upper trunk neuroma assists in planning resection and nerve grafting. It is particularly useful for stimulating the most proximal branches such as those contributing to the long thoracic nerve, confirming the presence of a good central connection to the nerve root stump. A good motor response to stimulating a fibrotic C7-middle trunk may be an indication for neurolysis rather than resection and grafting. Stimulation of C8 and T1 roots and the lower trunk helps confirm their identity when there is good hand function and may assist decision making when hand function is mediocre. Occasionally, one finds that only one of these two nerve roots can be stimulated, suggesting a more proximal avulsion of the other. The bipolar stimulator is helpful when one is attempting to locate the accessory nerve for a transfer to the suprascapula nerve. It also confirms that an identified nerve deep to the trapezius is the accessory nerve.

(3) In deep facial lacerations just anterior to the parotid, the bipolar stimulating forceps are used to localize small facial nerve branches on the anterior surface of the wound, which can then be repaired.

(4) Stimulation of the dissected motor fascicles to gracilis muscle assists with refinement and reduction of muscle bulk, particularly when a small functioning muscle transfer is required, such as in facial reanimation. The nerve to masseter is positively identified using the nerve stimulator before it is divided and coapted to the nerve to the gracilis free flap.

## Discussion

The Italian physiologist Luigi Galvani (1737–1798) was among the first to recognize the relationship between electrical stimulation of a nerve and the contraction of its muscle. In subsequent years, a range of probes and coils have been used to convey electrical impulses to the body with varying degrees of unpleasantness.[2] While a great many articles in the medical literature have investigated the physiological and anatomical aspects of nerve stimulation,[3,4] few have examined the means by which the electricity is administered. These discussions have been largely the domain of electrodiagnostic journals.

A variety of commercially available apparatuses can be easily accessed that will provide direct neural stimulation at a suitable microcurrent and appropriate frequency. One such instrument is the disposable Vari-Stim III (Medtronic Xomed Inc, Jacksonville, FL, reference number 85–62101), which is used extensively when neuromuscular reconstructive surgery is performed. It is reliable and uncomplicated but also costly, being single-use only and A$715 (US$557) for a box of 10. Additionally, with a single active electrode, its stimulatory precision may be less exacting than required where there is limited access, such as in the root of an infant's neck in an obstetric brachial plexus reconstruction. Stimulation of neural tissue using this monopolar device is imprecise. Electrons generated at the cathode tip travel through nerve fibers to a circuit-completing anode that has been placed in adjacent tissue. Using a pair of conventional bipolar forceps and an anesthetic impulse generator, the current is generated across the nerve fibre and generates an action potential that is then propagated down the axon.

This technique, developed by the senior author, is routinely used at Royal Children's Hospital, Melbourne, and its efficacy, ease of use, and robustness has been established over 10 years, with a succession of surgical trainees adopting it as the device of choice for nerve stimulation. There is no expense, as the two components are already standard equipment in most operating rooms. Reusable bipolar forceps will be in the operative field and can be unplugged from the electrocautery unit and connected to the impulse generator when required for nerve stimulation. There are, pleasingly, no contaminated, battery-containing plastic components to incinerate or add to land fills.

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Motor fascicles can be accurately localized using bipolar forceps and an anesthetic impulse generator as an inexpensive alternative to standard nerve stimulation devices.

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