Microstim Stimulator General Theory

Peripheral nerve stimulators have been designed to aid anesthetists detect and monitor neuromuscular function. They are used to assess the neuromuscular block during surgery and the reversal of neuromuscular block during the recovery period. By using a nerve stimulator a clinician can determine the effects of neuromuscular-blocking drugs and adjust the dosages accordingly by observing muscular response to different patterns of electrical nerve stimulation, The degree of neuromuscular relaxation is important in determining the timing of intubation and extubation.

Principles of operation

The Microstim delivers electrical current to a peripheral nerve, typically the ulnar nerve at the wrist; When the peripheral nerve is stimulated sufficiently the muscle fibres contract. If the intensity is increased further, the stimulus is described as supramaximal, but muscular contraction does not increase. By delivering the same amount of supramaximal stimulation before and after administration of neuromuscular-blocking drugs, the clinician can determine the effect of the neuromuscular block.

The Microstim supramaximal nerve stimulator is battery powered It is similar to other stimulators in offering four types of stimulation: Twitch, Train-of-four (TOF), Tetanic, Double burst.

These techniques produce specific responses or patterns of muscle contraction. The level or type of block is assessed by observing visually or tactilely the degree to which the affected muscle contracts.

Twitch:

Consists of a single supramaximal current and is applied repetitively at a frequency of 0.1 to 2 Hertz (Hz). The pulses are typically rectangular and have durations of 0.2 millisecond or less to avoid repetitive nerve firing. Single-twitch stimulation is the least sensitive method of demonstrating a partial neuromuscular block. The twitch response is not reduced until at least 75% to 80% of the nerve endings are blocked, and it disappears completely when 90% are blocked.

The Microstim applies 1Hz with a pulse duration of 0.2 milliseconds

Train of Four TOF:

Consists of four supramaximal stimuli at 2 Hz: at half-second intervals. The amplitude of the fourth response in relation to the first gives the TOF ratio, which begins to decrease when more than 70% of the receptors are blocked. TOF stimulation can be repeated every 8 to 12 seconds.

Some neuromuscular blocks cannot be evaluated using Single-twitch or TOF stimulation during deep relaxation, because the associated response can disappears for extended periods e.g greater than 5 minutes

Tetanic :

Can consist of pulses at a much higher rate (30 to 100 Hz).

Greater sensitivity is possible at higher frequencies. but at 100 Hz for 5 seconds a lack of appropriate response develops when 50% of the receptors are blocked; and at 200 Hz for 5 seconds there is insufficient response when only 30% of the receptors are blocked.

Tetanic stimulation can be painful and under certain conditions may influence the course of the neuromuscular block in the investigated muscle.

The Microstim supplies 50Hz applied for 5 seconds, a 3 second pause , then 1Hz for 30 seconds

Microstim Stimulator General Theory

Double-burst:
Consists of either two trains of three pulses at approximately 50 Hz, separated by approximately 0.75 milliseconds, (3.3) or an initial train of three pulses followed by a train of two pulses (3.2).
The neuromuscular response consists of two short muscle contractions, the second of which is significantly less forceful than the first. The ratio of these contractile forces indicates the degree of patient drug-induced muscular relaxation.
The Micostim consists of 3 pulses at 50Hz followed by a 0.75 second pulse then 2 pulses at 50Hz

Application of the stimuli
Motor fibres are stimulated before pain fibres and as low stimulating currents are used for regional anesthesia the patient feels minimal discomfort
Conventional EKG disposable electrodes are most commonly used for applying the stimulation as they provide good contact with low impedance.

Ball Electrodes
Some competitive models are also equipped with ball electrodes mounted on the stimulator This method was rejected due to the possibility of varying skin impedance caused by the small to area of application and the conductive properties of the skin . Intermittent conductivity could cause inadvertent large jumps in the energy levels being applied.
Burns are unlikely to occur with peripheral nerve stimulators because they use low current and typically only briefly impart electrical energy through the skin.
The Microstim was designed to be battery driven as this eliminates many of the perceived risks in relation to burns particularly with earth leakage currents and alternative paths via electrosurgical units

Microstim Specifications
Typical current mA into 1000 ohms
Pulse width
Pulse Indicator LED
Battery type MN1604 9volt
Battery state indicator 3 colour LED
Battery capacity
Height
Width
Depth
Weight gms oz

Terminal polarity indication:
Indicates the positive and negative bipolar electrodes.
Leads must comply with FDA "protected" lead set requirements

Pacemakers
Problems have been reported with use of peripheral nerve stimulators during surgical procedures. E.g pace-maker during surgery. Pacemaker function returned to normal upon cessation of peripheral nerve stimulation. Suitable warnings are given in the instructions

Microstim Stimulator General Theory

Associated Papers

Barthram CN. Nerve stimulators for nerve location — are they all the same? A study of stimulator performance. *Anaesthesia* 1997 Aug;52(8):761-4.

Beemer GH, Reeves *JH.* An evaluation of eight peripheral nerve stimulators for monitoring neuromuscular blockade. *Anaesth Intensive Care* 1988 Nov; 16(4):464-72.

Dankle JA, Wiegand DA. Investigation of a coaxial bipolar nerve stimulator for intraoperative motor nerve monitoring. *Laryngoscope* 1994 May; 104(5 Pt 1):619-22.

Ehrhardt JC, Lin CS, Magnotta VA, et al. Peripheral nerve stimulation in a whole-body echo-planar imaging system. *J Magn Reson Imaging* 1997 MarApr;7(2):405-9.

Gravenstein JS, Paulus DA. *Monitoring practice in clinical anesthesia.* 2nd ed. Philadelphia: JB Lippincott; 1987:178-91.

Grill WM, Mortimer JT. Non-invasive measurement of the input-output properties of peripheral nerve stimulating electrodes. *J Neurosci Methods* 1996 Mar;65(1):43-50.

Hadzicá A, Vloka JD. Peripheral nerve stimulator for unassisted nerve blockade. *Anesthesiology* 1996 Jun;84(6):1528-9.

Myirea KC, Hameroff SR, Calkins JM, et al. Evaluation of peripheral nerve stimulators and relationship to possible errors in assessing neuromuscular blockade. *Anesthesiology* 1984 May;60(5):464-6.

O'Flaherty D, Wardill M, Adams AR Inadvertent suppression of a fixed rate ventricular pacemaker using a peripheral nerve stimulator. *Anaesthesia* 1993 Aug;48(8):687-9.

Rowlee SC. Monitoring neuromuscular blockade in the intensive care unit: the peripheral nerve stimulator. *Heart Lung* 1999 Sep-Oct;28(5):352-62.

Sansome AJ, de Courcy JG. A new dual function nerve stimulator. *Anaesthesia* 1989 June;44(6):494-7.

Tiel RL, Happel LT Jr, Kline DG. Nerve action potential recording method and equipment. 2~eurosurgery 1996 Jul;39(1):103-8.

Weiner RL. The future of peripheral nerve neurostimulation. *Neurol Res* 2000 Apr;22(3):299-304.

Inberg P. Annila I, Annila P. Double-injection method using peripheral nerve stimulator is superior to single injection in axillary plexus block. *Reg Anesth* 1999 Nov-Dec;24(6):509-13.

Franco CD, Vieira ZE. 1,001 subclavian pen-vascular brachial plexus blocks: success with a nerve stimulator. *Reg Anesth* 2000 Jan-Feb;25(1):41-6.

Carles M, PulciniA, MacchiP, et al. An evaluation of the brachial plexus block at the humeral canal using a neurostirnulator (1417 patients): the efficacy, safety, and predictive criteria of failure. *Anesth Anaig* 2001 Jan;92(1):194-8.

Existing International Standards

Blue Cross and Blue Shield Association. Electrical nerve stimulation [technology assessment report]. 1988

International Electrotechnical Commission. Medical electrical equipment — part 1: general requirements for safety [standard]. IEC 60601-1 (1988-12). 1988.

Medical electrical equipment — part 1: general requirements for safety. Amendment 1 [standard]. IEC 60601-1-aml (1991-11). 1991.

Medical electrical equipment — part 1: general requirements for safety. Amendment 2 [standard]. IEC 60601-1-am2 (1995-03). 1995.

Medical electrical equipment — part 1: general requirements for safety. Section 2. Collateral standard: electromagnetic compatibility — requirements and tests, IEC 60601-1-2 (1993-04). 1993.

Medical electrical equipment — part 2: particular requirements for the safety of nerve and muscle stimulators [standard]. JEC 60601-2-10 (1987-12). 1987.