CLINICAL | WINDOW

Technical Briefs

Technology description of NMT measurement

NeuroMuscular Transmission (NMT) is the transfer of a motor nerve impulse into the muscle over the neuromuscular junction. NMT can be blocked by neuromuscular blocking agents (NMBA). The level of neuromuscular block is routinely measured by stimulating a peripheral nerve and by evaluating the muscle response either visually or by touching the moving limb, usually the hand. The Datex-Ohmeda NMT module provides quantitative, automatic measurement of muscle response to an electrical stimulus. The evoked response can be measured either by the traditional ElectroMyoGraphy (EMG) or by the unique MechanoSensor quantifying the evoked motion of the thumb.

Peripheral nerve stimulation

Excitation of the nerve is triggered by pulses of electric current. Two stimulating electrodes are placed along eq. the ulnar nerve. (Figure 1)

One of the most important determinants of the evoked muscle response is the amplitude of the stimulation current. The NMT module automatically searches first the current needed for a supramaximal stimulus.

The NMT module delivers a wide range of stimulating patterns, allowing for the differentiation between depolarizing and non-depolarizing block.

Supramaximal current

Increasing the stimulating current until the evoked response remains constant searches the maximal current, the stimulating current intensity required for depolarization of all fibers of a nerve bundle. The maximal current is increased by 15 % to obtain the Supramaximal Current, which is used in stimulation, to eliminate the effect of current intensity. The NMT module automatically searches first the current needed for a supramaximal stimulus.

Single Twitch (ST)

In Single Twitch stimulation, one supramaximal, 100 – 300 µs duration stimulation pulse is generated at user-adjustable time intervals.

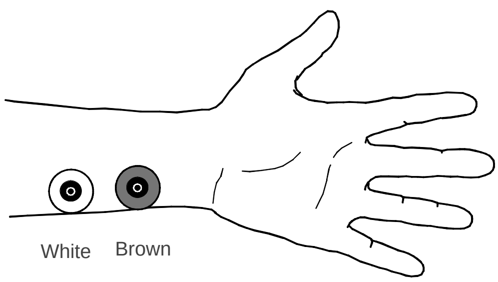

Fig. 1. Nerve Stimulation

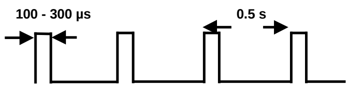

Fig. 2. Train of Four

Train of Four (TOF)

In Train Of Four stimulus mode, four individual Single Twitch stimuli are generated at 0.5 s. intervals. (Figure 2)

Double Burst (DB)

Double Burst stimulation includes two bursts with a 750 ms interval. Both bursts consist of three pulses separated by a 20 ms interval (DBS $_{3,3}$).

Tetanic Stimulus and Post Tetanic Twitch Count (PTC)

In Tetanic Stimulation, pulses with a 20 ms interval are generated with selected pulse width and current for 5 seconds. Post Tetanic Twitches follow the Tetanic Stimulus after 3 s and consist of a maximum of 20 Single Twitches at 1 s interval.

Monitoring the evoked muscle response

Clinicians monitor the evoked responses objectively, subjectively or both. Objective methods measure evoked electrical response (electromyography, EMG), muscle force or movement response or acceleration of the finger movement.

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EMG response

Electromyography is the process of recording the electrical activity of a muscle in response to nerve stimulation. The signal obtained depends on the location of the recording electrodes relative to the muscle. Two recording electrodes are used to record the compound EMG wave, while the third one (Black) serves as ground. If the ulnar nerve is stimulated either the adductor pollicis, abductor digiti minimi or the first dorsal interosseus muscle (green and red) used. (Figure 3)

ElectroSensor

Datex-Ohmeda ElectroSensor consists of the two stimulating electrodes and three measurement electrodes.

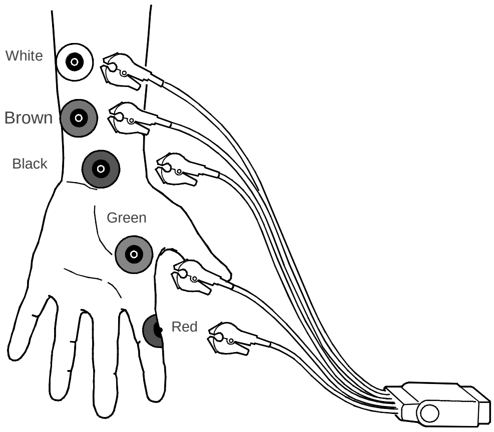

Fig. 3. ElectroSensor

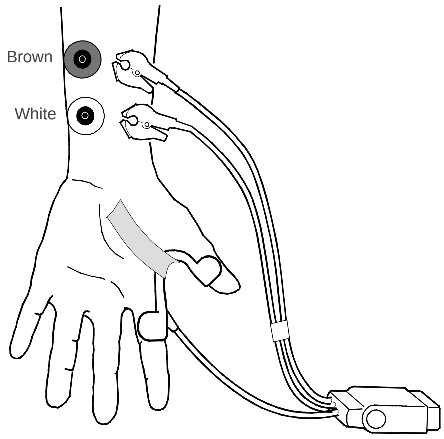

Fig. 4. MechanoSensor

KMG response

During kinemyographic measurement the contraction of a muscle group (usually the adductor pollicis muscle) in response to nerve stimulation (usually the ulnar nerve) is translated into an electrical signal via a piezoelectric transducer. The unique Datex-Ohmeda MechanoSensor quantifies the evoked response by measuring the motion of the thumb. The sensor consists of two stimulating electrodes and a sensor, which is placed between the thumb and the forefinger. (Figure 4)

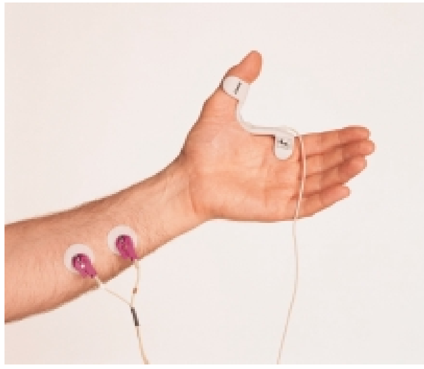

Fig. 5. MechanoSensor

MechanoSensor

The core of sensor is a strip of piezoelectric polymer, which is housed inside the sensor. Piezoelectric material is used also in acceleration sensors, but here the characteristics of the material are used to detect movement, ie. deformation of the material when it is bent by the adductor pollicis muscle. (Figure 5)

When piezoelectric material is deformed, the electric charge in the material is redistributed. This leads into electron flow to balance the charge, and this flow can be measured as a voltage, which is proportional to the amount of deformation.

When the ulnar nerve is electrically stimulated, the thumb moves and bends the sensor and the piezoelectric element inside. The signal created by the element is measured during the movement, and this signal is proportional to the angular velocity of the thumb movement. The size of the area under the angular velocity curve (Figure 6) illustrates the amount of the thumb movement (bending) within a certain time interval by integrating this signal over time the magnitude of the muscle response can be given.

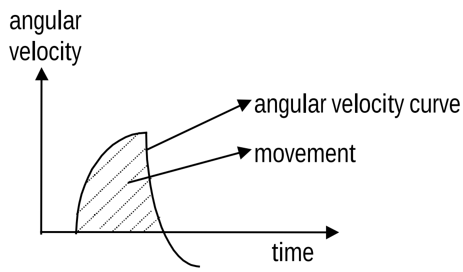

Fig. 6. Muscle response measurement

The angular velocity of the thumb depends on the number of the contracting muscle fibers, which varies as a function of the level of neuromuscular block, but it is also dependent on the positioning of the sensor on the hand. The sensor needs to be fixed to the hand with a narrow tape to prevent it from moving during the case. Immobilization of the hand, however, is not necessary, as the position and direction of the thumb do not affect the measurement, as long as the thumb is able to move freely. A baseline calibration is not needed as the Train of Four ratio or the number of detected responses is given.

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