Needle EMG

Preston and Shapiro has several nice chapters that review basic electromyography - see chapters 14 (spontaneous) and 15 (voluntary) for fundamentals of EMG.

Settings

Sweep speed is the horizontal measurement and gain is the vertical measurement. In general, gain is set to 50 uv/div for spontaneous recordings and 200 uv/div for voluntary MUAP (motor unit action potential) recordings with 10 msec/div sweep speed. There are 10 divisions vertically and 20 divisions horizontally (200 msec or 1/5th of a second). A concentric needle only assesses 7-15 muscle fibers of a given MUAP or even overlapping MUAP at a time. Most skeletal muscles have 100-300 motor units, extraocular has 20 motor units. (extraocular & laryngeal motor units may be as small as 3-5 muscle fibers and gastrocnemius may have as many as 2000-3000 muscle fibers per motor unit)

Grading Spontaneous Activity

Fibrillations and Positive Waves = unstable muscle membrane — often neurogenic but can see in wide range of myopathic and NMJ (Botulinum) conditions

- 0: None present
- Unsustained: p waves of fibrillations lasting less than 2 seconds
- 1+: Persistent trains of p-waves or fibrillations lasting 2-3 seconds in at least two areas
- 2+: Moderate number of p-waves or fibrillations in 3 or more areas
- 3+: Many potentials in all areas
- 4+: Full interference pattern of potentials (rare)

Very regular firing rate of 0.5-10 Hz

Fasciculations = Involuntary discharge from motor axon (motor unit) — may be pathogenic or normal; grading is more arbitrary

- 0: None present
- 1+: 1-10 per minute
- 2+: 11-25 per minute
- 3+: 26-50 per minute
- 4+: > 50 per minute

Irregular firing rate, usually less than 1-2 Hz

Best way to observe fasciculations is to insert the needle and then remain stationary or take your hand off the needle

Grading Voluntary Motor Unit Action Potentials (MUAP)

Amplitude

Technically amplitude equates to muscle fiber density, so will increase if a reinnervated motor unit acquires more muscle fibers or muscle fibers hypertrophy, small changes in amplitude are not really sensitive for differentiating neurogenic from a myopathic process, but if significant increase in MUAP amplitude then likely represents a neurogenic loss of muscle fibers. Keep in mind that amplitude is also a function of the distance of the needle to the motor unit (father distance = smaller appearing motor unit with slower rise time).

Measured when recording needle is closest to muscle fibers as indicated by steepest rise time and highest possible amplitude. Measure the amplitude from negative peak (positive deflection) to bottom of positive peak (negative deflection). Using sweep speed of 200 ms/screen (20 ms/div x 10 divisions) and gain of 200 uV/division (200 uV x 10 = 2000 uV). MUAP tend to have larger amplitudes in distal muscles and smaller amplitudes in proximal muscles. MUAP amplitude of the Biceps Brachii should be <1000 uV (1 mV), but distal muscles could have somewhat taller MUAP amplitudes up to 2 mV. Most MUAP should be >100 uV, but keep in mind the normal Biceps Brachii can have 25% of fibers at 100 uV and 13% at 50 uV (Buchthal F, et al. Action potential parameters in normal human muscle and their dependence on physical variables. Acta Physiol Scand 1954;32:200)

Rule of Thumb for grading increased amplitude:

- >1000 and <2000 uV, MUAP fill screen when set at 200u V/div = +1 (but be cautious distal muscles may have normal units close to 2000 uV)
- >2000 and <5000 uV, MUAP off screen at 200 uV but not at 500 uV/div = +2
- >5000 and <10,000 uV, MUAP off screen at 500 uV but not at 1 mV= +3
- >10,000 uV (10 mV) off screen or completely filling screen at 1 mV= +4

Rule of Thumb for grading decreased amplitude:

- Majority of units <200 uV in distal muscles = decreased amplitude
- Majority of units <100 uV in proximal muscles = decreased amplitude
- Again -4 decrease in amplitude will be very rare.

Duration
Best reflects number of muscle fibers in the motor unit and the dispersion of their depolarizations over time. It increases with age and with decreased temperature. Challenging to measure in real time, as must be able to determine beginning and end of MUAP. Correlates with pitch - wide duration = dull thud while shorter duration = sharp & crisp. Normal range is 5-15 msec. (1.5 divisions at 10 msec/div is increased duration while less then half a division is decreased. Duration correlates best with neurogenic and myopathic conditions.

Polyphasia

Number of phases reflect muscle fiber diameter as diameter affects conduction of muscle fiber AP, and phases reflect how well nerve conducts the AP to muscle fibers. Phases may increase if muscle fibers AP are out of sync such as in reinnervation or muscle damage. Not specific for myopathic or neurogenic process.

Phases are the number of baseline crossings +1 or the number of negative and positive peaks that extend from the baseline. Phases should be < 4. However, 5-10% may be >4 and 25% of deltoid MUAP are >4 phases.

Turns (serrations) are changes in directions that don't cross the baseline and should be 5 or less. A combination of phases and turns is termed a complex MUAP. By changing needle position can change turns into phases and vice-versa.

Recruitment

Refers to the frequency of MUAP firing relative to force. Abnormal recruitment is a neuromuscular pathological process. If a patient is unable or unwilling to move a limb or contract the muscle this is decreased activation. Decreased activation occurs in CNS disorders, conversion disorder, or pain inhibition.

Hz = 1 cycle/sec. Screen 10 div x 20 msec/div = 200 msec

1 cycle/sec = 1/200 msec x 1000 msec/sec = 1000/200 = 5 Hz frequency of MUAP firing if only one unit is seen per 200 msec screen

If clearly see 2 units per screen then unit firing at 10 Hz: If 3 units then 15 Hz; if 4 units then 20 Hz. At 10 Hz with normal recruitment a second unit is recruited. If recruitment is decreased that unit will fire faster than 10 Hz appear on the screen more then twice.