Electromyography

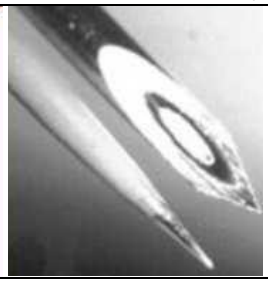
Technique of evaluating and recording the electrical activity produced in skeletal muscle. Instrument is called electromyograph and record is called as electromyogram.

Uses

NEUROLOGICAL EMG	KINESIOLOGICAL EMG
It can determine the location of abnormality- differentiate focal nerve, plexus, or radicular pathology. It distinguishes myopathy or neurogenic muscle weakness. It detects abnormalities like chronic denervation or fasciculations in clinically normal muscle. It can provide supportive evidence of the pathophysiology of peripheral neuropathy, either axonal degeneration or demyelination. EMG is an obligatory investigation in motor neuron disease.	Analysis of demand of muscles and risk prevention. Movement analysis Athletes strength training Sports rehabilitation

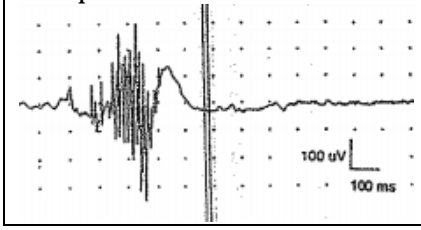
Methodology

Two types of electrodes- inserted fine wire/needle and surface types (bipolar/array).

Each muscle tested in four quadrants or ten locations with five needle movements in each quadrant or location. Conventional EMG needles record from a hemisphere of radius of about 1-2.5 mm (approximately 100 muscle fibres).

Phase 1:-During insertion of the needle, the muscle gives mechanical discharge- Amplitude several 100 microvolts and duration several milliseconds.
insertional activity.
It is diminished in fibrotic or edematous muscle.
Increased in an inflammatory myopathy or denervated muscle (more Acetylcholine receptors on entire muscle fibres rather only at neuromuscular junction).



Phase 2:-Once needle is at rest, and muscle is completely relaxed, the EMG is silent.

Spontaneous activity occurs in few conditions.

nerve transection/ Inflammatory myopathy	Motor neuron disease/ Radiculopathy/ thyroid disease/tetany	myokymia	neuromyotonia	Myotonia 20-300mV
Fibrillations (acute) Positive wave (acute) Complex repetitive discharge (chronic)	fasciculations	Brainstem disorders/ demyelination of nerves	Autoimmune antivoltage gated k^+ channelopathy	Dystrophia myotonica

Fibrillation- it is action potential from a single muscle fiber. Very short, biphasic potential of low amplitude not detected clinically. Duration-0.5ms, amplitude is 20mV. *Rain on roof sound*.

Positive sharp waves- are recorded from a single muscle fiber and are small downward deflections on the oscilloscope due to damage of muscle fibres by needle tip or acute nerve damage. *Clap of distant thunder sound*.

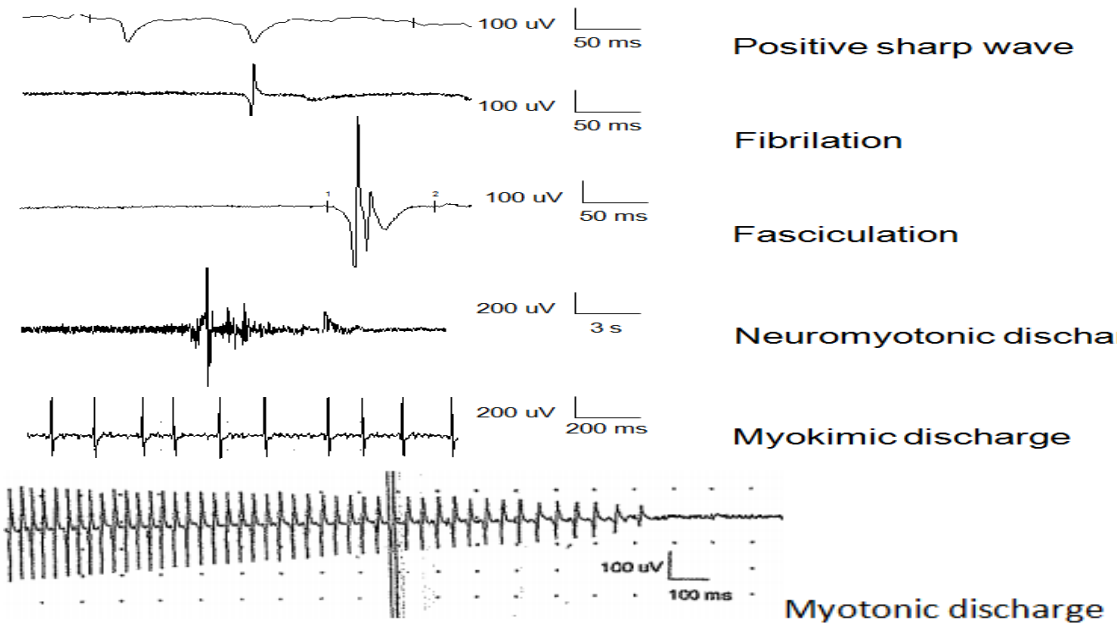
Complex repetitive discharge- seen in chronic partial denervation. *Begins and ends abruptly*. Frequency is 1-100 Hz.

Myotonia- needle movements/tapping on muscle provokes discharges.-dive bomber sound. Vary in frequency and amplitude and reduces the amplitude with time.

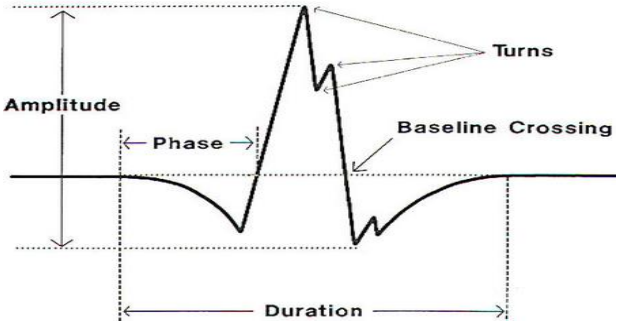
Fasciculations- action potential from single motor unit (axon level). Clinically detectable at frequency less than one per second. Pathological >3/10 sec. duration-5-15ms. Amplitude <300mV.

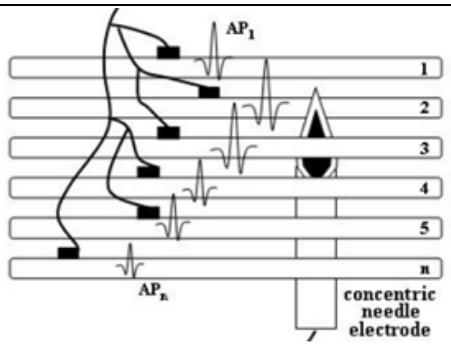
Myokymia-action potential from group of motor units. Amplitude-100microV-2milliV.

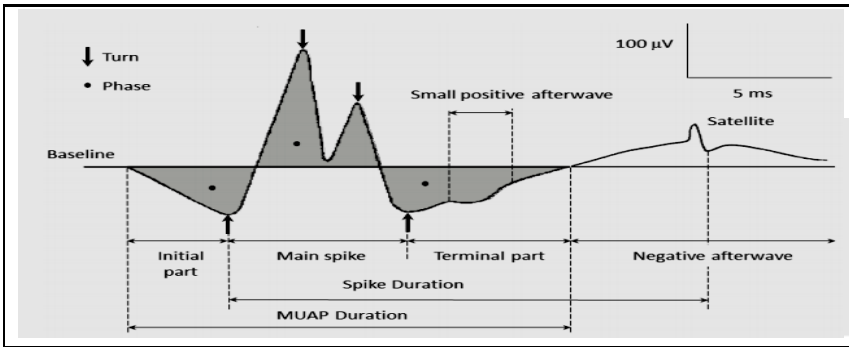
Neuromyotonia-hyperexitability of single peripheral motor axons. Doublet, triplet high frequency short duration bursts (200 Hz) - ping sound in EMG.

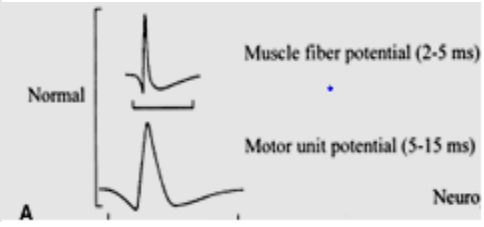


Next is evaluation of motor unit potentials.
Phase 3:-Patients were requested to activate the muscle *minimally*.
A normal MUP has four or fewer phases with each phase being a cross and return to the baseline. If it has more than four phases, the MUP is called polyphasic or complex. Each change in the direction of a portion of the MUP is called a turn. Recruitment refers to the successive activation of the same & additional motor unit with increasing strength of voluntary muscle contractions. Recruitment- activation of motor units-small slow twitch fibres are recruited first followed by fast twitch oxidative and lastly fast twitch glycolytic fibres. Satellite potiental is due to incomplete myelin formation and immature terminal sprouts from chronic reinnervation or a myopathy.









Velocity of conduction in muscle→4m/s, Absolute refractory period→1-3ms
Normal resting potential of muscle→-90mV
Normal amplitude→0-10mV, Duration→5-15ms
Action potential of muscle fibre→2-5 ms., motor unit potential→5-15ms
Typical repetition rate of muscle motor unit firing is about 7–20 Hz,

<u>Small MUs are recruited first</u>

Reduced recruitment with increase in frequency-pain, neurogenic- chronic partial denervation, demyelinated nerves (decrease in number of motor units- firing >35Hz to compensate the loss).
Early recruitment and increased recruitment-myopathy and inflammatory myositis (to compensate for less force generated by a small motor unit, more motor units fire early during muscle contraction).
Polyphasic, long duration and long amplitude-collateral sprouting. MC in neuropathic disease.
Polyphasic, short duration and short amplitude-dropout or dysfunction of muscle fibres.
Unstable potentials-seen in neuromuscular disorder.
Giant potentials-large MUAP (>5mV) seen in poliomyelitis

Phase 4:-Interference Patterns -Motor unit pattern with maximal voluntary activation of muscle.

This is a qualitative or quantitative description of the sequential appearance of MUAPs.

It composed of recruitment plus activation. Activation is the ability of a motor unit to fire faster to produce a greater contractile force and controlled by central process.

Decreased in CNS disease, pain, and hysteria.

During early motor neuron disease, the interference pattern is often diminished despite good patient effort. During early myopathy, however, the interference pattern is usually full.

Complete pattern	No individual MUAP can be seen. A full screen 4-5 MUAP
Reduced pattern	Some MUAP are identified on screen during full contraction
discrete	Each MUAP are identified on screen during full contraction
Single unit	One MUAP is identified on screen during full contraction

	Lesion / EMG Steps	Normal	Neurogenic Lesion		Myogenic Lesion	
			Lower Motor	Upper Motor	Myopathy	Polymyositis
1	Insertional Activity	Normal	Increased	Normal	Normal	Increased
2	Spontaneous Activity		Fibrillation, Positive Wave			Fibrillation, Positive Wave
3	Motor Unit Potential	0.5-1.0 mv, 5-10 msec.	Large Unit, Limited Recruitment	Normal	Small Unit, Early Recruitment	Small Unit, Early Recruitment
4	Interference Pattern	Full	Reduced, Fast Firing Rate	Reduced, Slow Firing Rate	Full, Low Amplitude	Full, Low Amplitude

MUAP abnormality	Anatomical phenomena related
Decreased amplitude	Muscle fibers' atrophia Increasement of connective tissue Excessive jitter and blocking
Increased amplitude	Muscle fibers grouping (reinervation, regeneration) Muscle fibers hypertrophia
Decreased duration	Muscle fibers' atrophia Loss of muscle fibers Serious MUAPs blocking in endplate
Increased duration	Increase in the number of muscle fibers (collateral growing)
Increased spike duration	Variation in the diameter of the muscle fibers Increase in the width of the endplate
Increase in the number of turns and phases	Slow conduction in terminal axons Increase in the width of the endplate Increase in the variability of the diameter of muscle fibers
Increase in the firing rate	Loss of MUs Decrease in the force generated by individual MUs