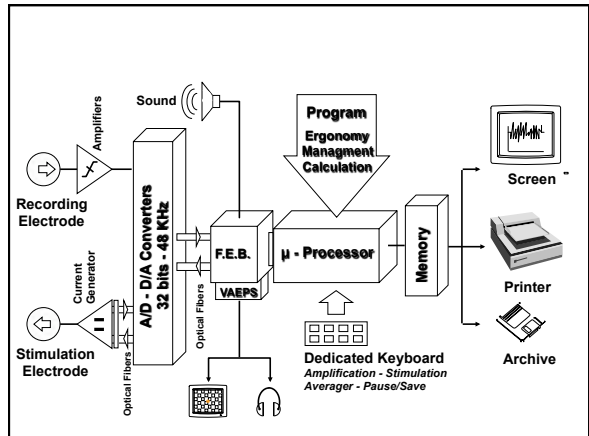


Analyse et traitement du signal en électrophysiologie périnéale

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 Service de Neuro-Urologie et d'Explorations Périnéales
 Hôpital Tenon APHP, GRC UPMC 01

green upmc

DIU NEURO-UROLOGIE, Anney, Vendredi 30 Mars 2012



Digital Conversion Sampling

Time Sampling of one or more magnitudes

Frequency 5 times (minimum) the highest frequency to be sampling

Binary conversion (12 bits)
 (t+1) 5mV amplitude that is **00000000101**
 (t+n) 100mV amplitude that is **000001100100**

EMG Signal & Concentric Needle

Active $1 < Z < 100 \text{ K}\Omega$ - Z must be as lower as possible

Electromyographic Signals

Non focused trace
 Damped noise
 High impedance
 Used Needle

Focused trace
 Incisive and curt noise

Preamplifier and Environnement

Environmental Interferences penetrate Patient Patient Must Be Grounded

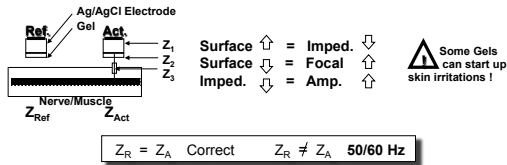
Balanced Inputs
 50 - 60 Hz counterbalanced
 $V^+ + V^- = 0$

High Input Impedance $>1500 \text{ MOhms}$ and Rejection $>100 \text{ dB}$

Patient is Antenna ! Interferences are transfered

Power Lines
 Neon - Variators
 Radiology Surgery
 Sharp Waves
 Spikes
 High freq. PW
 High freq. PW
 Radio
 Central Servers
 Mobil Phone
 AM/FM Radio CB
 Power Supply

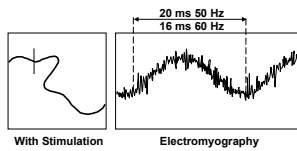
Rec. Surface Electrode Impedance



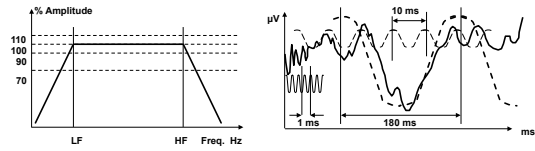
Baseline not stable ?

$Z_{Ref} \neq Z_{Act}$

- Skin contact
- Dry electrode
- Poor electrode quality
- Defective cable
- Defective Input Connector



Band Pass and Filters



Amplitude of EMG or EP signal depend of filter adjustment.

A precise adjustment provide a better trace without unsuitable frequencies as :

- Muscular noise
- External interferences
- Unstable brain activity
- etc..

- Many frequencies in the *Ref* signal
- Role of filters isolate suitable frequencies

In this case 10 and 180 ms

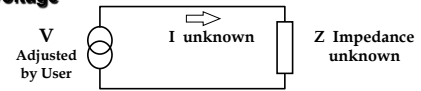
- Frequencies 100 Hz and 5.5 Hz
- HF \Rightarrow minimum $100 \times 2 = 200$ Hz
- FB \Rightarrow maximum $5.5 / 2 = 3$ Hz

Routine Setup in Practice

Electrode	EMG			NC	Evoked Potentials					
	CN-MN	Special	Special	Surface	EP Needles or Surface					
Tests	MUP IP T/A	SF	Macro	SNC MNC F-H Blink Decrem'	SEP	AEP A1-A2	VEP O1-O2-Oz			
		SF	Canula		Cortex	Others	AEP	P300		
High FQ [KHz]	10 200	10	10	2	2	1	2	0,1		
Low FQ [Hz]	or More	or More	or More							
	10	500	500	5	20	0,5	20	50	0,2	0,5
Sweep ms/Div	10 - 20	1 - 2	1	10	See Applications	10	5/10	1	100	30

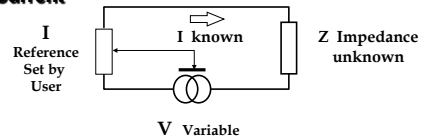
Stimulators Constant Voltage - Constant Current

Constant Voltage



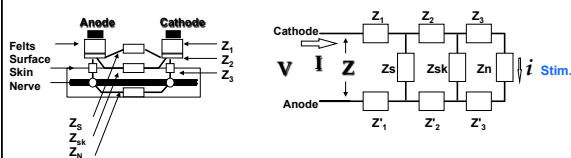
Nerve Stimulation Intensity Unknown : No Reference

Constant Current



KEY POINT

Stim. Surface Electrode Impedance



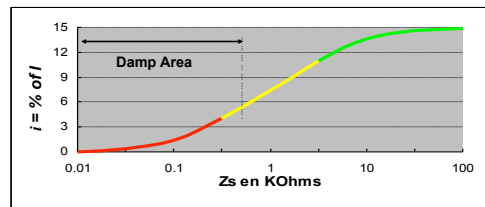
With $Z_1 \sim 0,5 \text{ K}\Omega$ $Z_2 \sim 1 \text{ K}\Omega$ Z_3 Z_{sk} $Z_n \sim 0,2 \text{ K}\Omega$
 $i \text{ Stim.} = 0,15 \times V \times Z_s / (1 + Z_s)$

$Z_s \downarrow \Rightarrow i \text{ Stim.} = 0 \text{ mA}$

$Z_s \uparrow \Rightarrow i \text{ Stim.} = V/7 \text{ mA}$

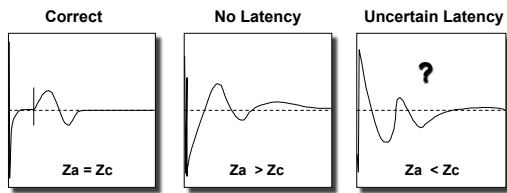
Stim. Surface Electrode Shunt Action

Zshunt Action on Current Stimulation i

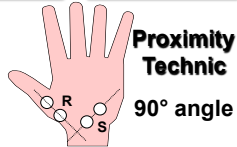


In damp area, Current Stimulation must be higher, Higher current = more artifacts !

Stimulation Artifact *balanced Impedances*



Unbalanced impedance between Z_anode and Z_ccathode give positive or negative variation of stimulus artifact !

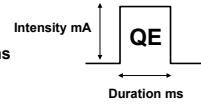


Intensity & Duration *Stimulation*

Stimulation is defined by Intensity and Duration :
Quantity of Electricity (QE)

You get the same QE with :

10 mA / 0,2 ms and 20 mA / 0,1 ms



Reminder :

- Long Duration gives Larger Stimulus Artifact
- Higher Intensity is painful
- Short Duration, Limitation in Max. of QE (depth nerves - Fat patient)
- It's better (for patient) to reduce the number of stimuli

Averager *Principle*

Extract a revealed potential buried in an activity
1000 times greater or more.

Two methods:

Sum-Mean

$$\frac{1+2+n}{n}$$

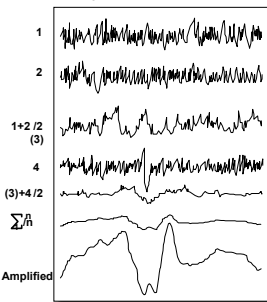
n is set before to start
Wait n reached

Normalized

$$\frac{\frac{1+2}{2} + 3}{2} + n$$

Possibility to stop
averager at any time.
n is an actual value

KEY POINT



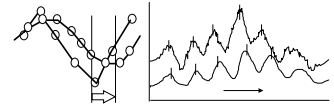
Smoothing Technics

Post-Calculation

Mean Value of 3 points
Then Interpolation of points

More smoothing =

- Latency displacement
- Amplitude decreasing

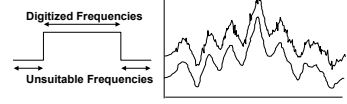


Post-Digitized

Re-Digitized Signal
with new pass-band

More smoothing =

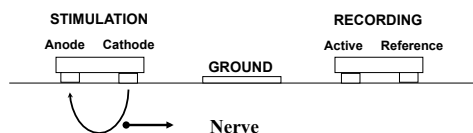
- Amplitude decreasing



KEY POINT

Ground *Stimulation & Recording Rule*

As Possible, Ground must be placed between Stim. & Rec.



BLACK TO BLACK

Stimulation Polarity : NEGATIVE

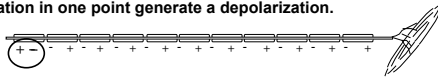
NERVE CONDUCTION

MNC - SNC - F.WAVES - INCHING




Stimulation

Nerve is a Chain of Polarized Cells (Myelin Action)

Stimulation in one point generate a depolarization.



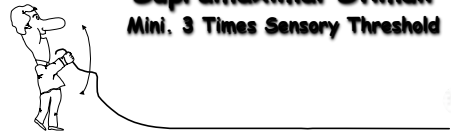
A Nerve could be Depolarized by :

-  Electrical Choke
-  Mechanical Compression
-  Magnetic Field

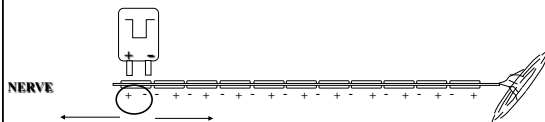
Current Stimulation



Supramaximal Stimuli
Mini. 3 Times Sensory Threshold



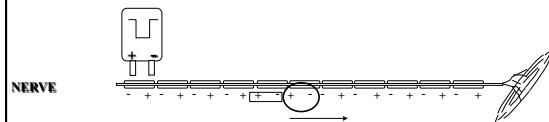
Depolarization



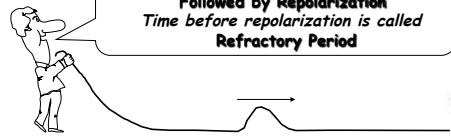
Once a Nerve is Depolarized at some point, a Wave of Depolarization passes in Both Directions from that point.



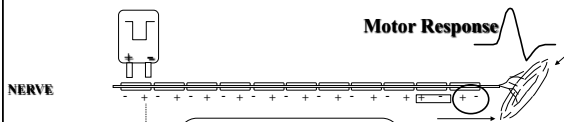
Propagation - Refractory Period



Propagation by Successive Depolarizations Followed by Repolarization
Time before repolarization is called Refractory Period



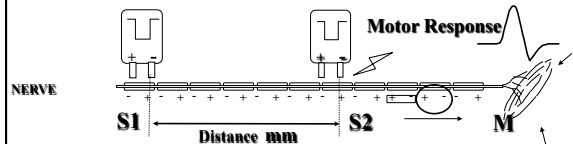
Motor Latency



MOTOR LATENCY
in ms =
Propagation Time
from S to M



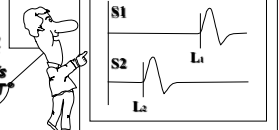
Conduction Velocity

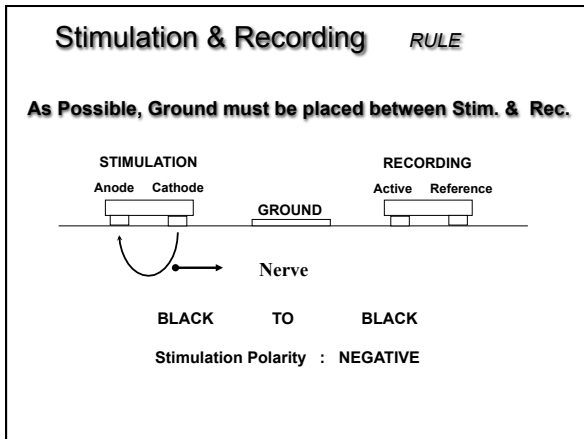
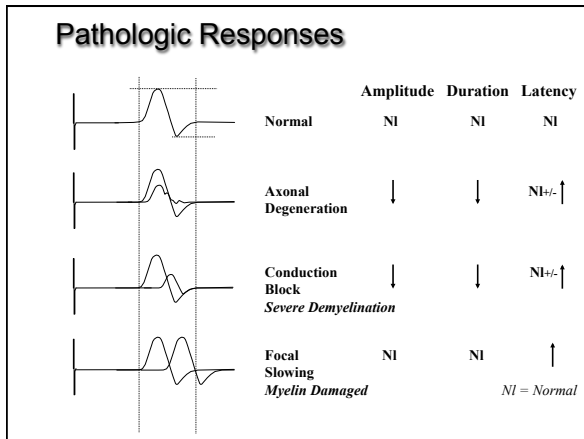
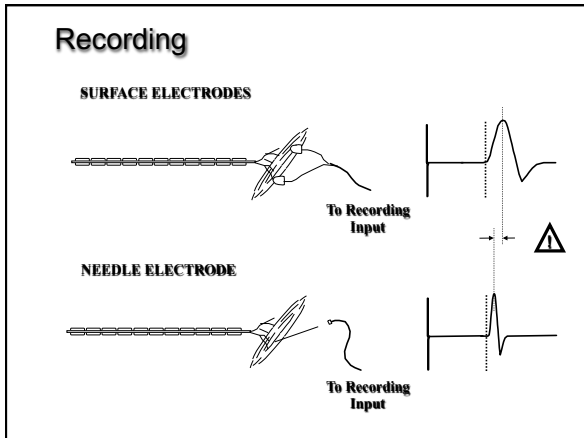
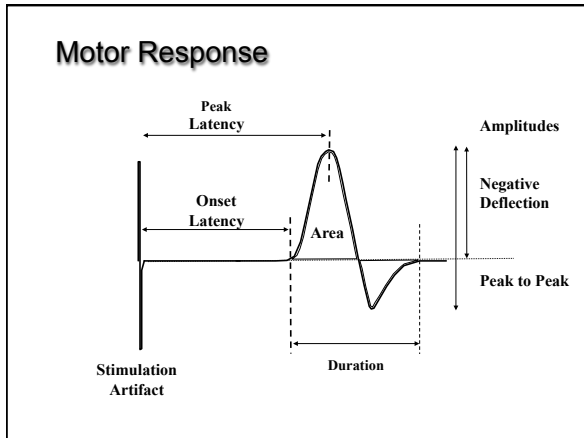


VELOCITY in m/s

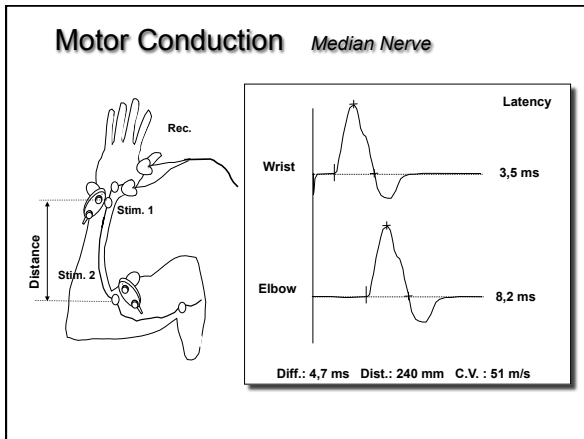
Distance
Latency S1 - Latency S2

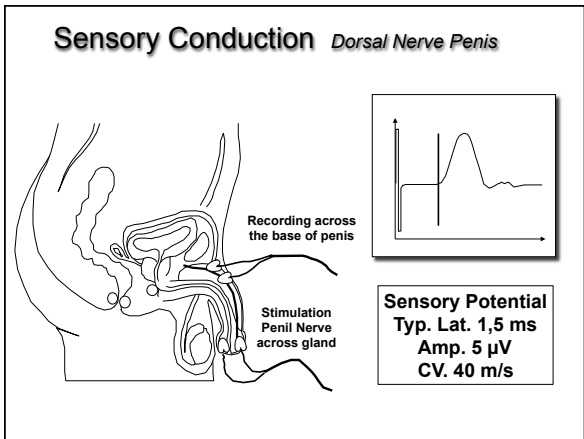
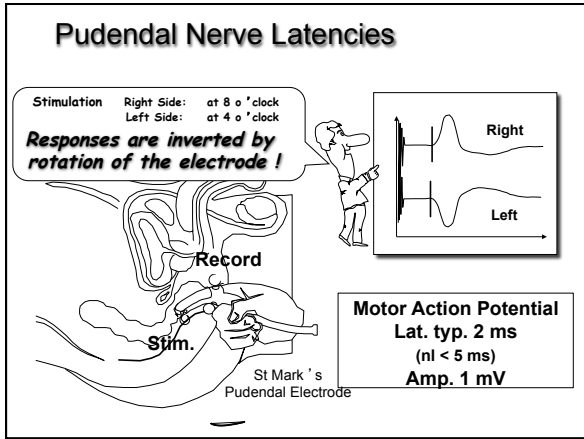
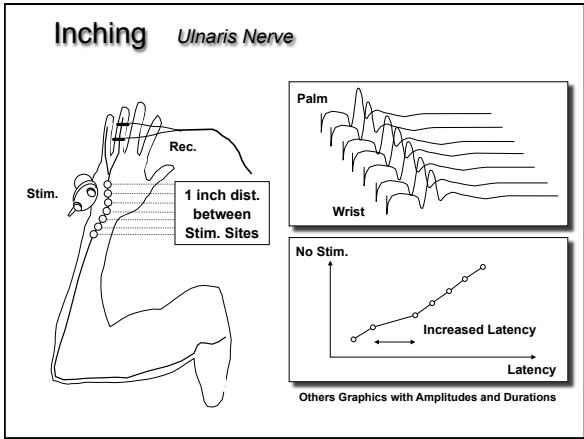
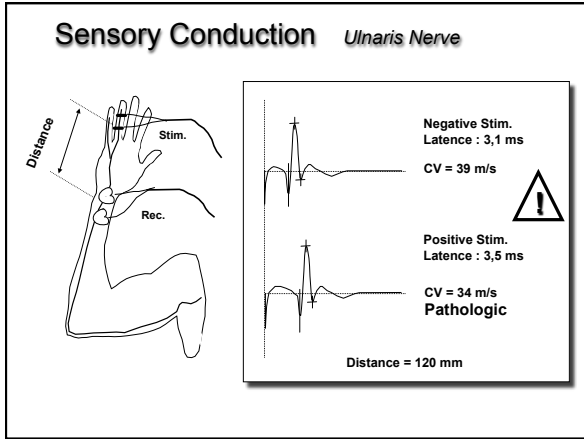
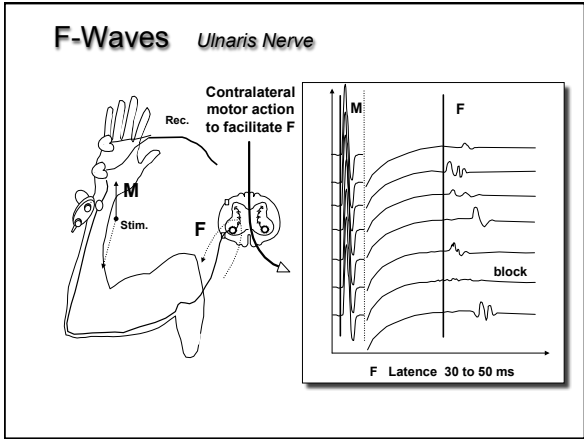
Normal Value : 45 to 65 m/s
Depend. of : Nerve - Age - T[°]





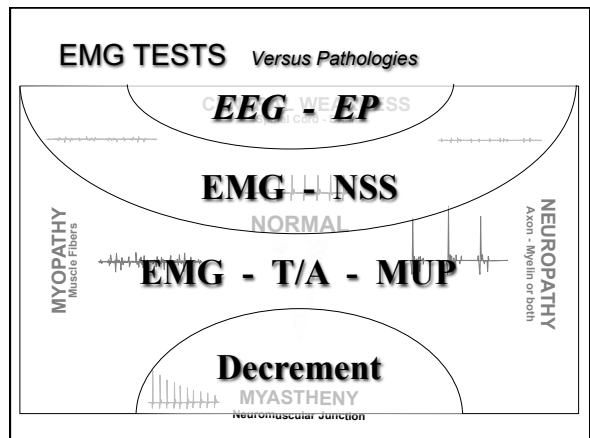
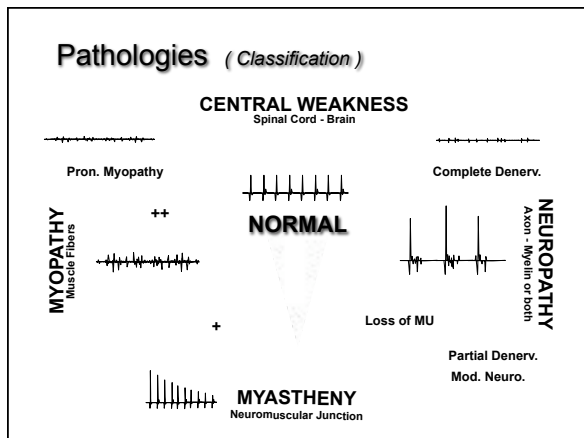
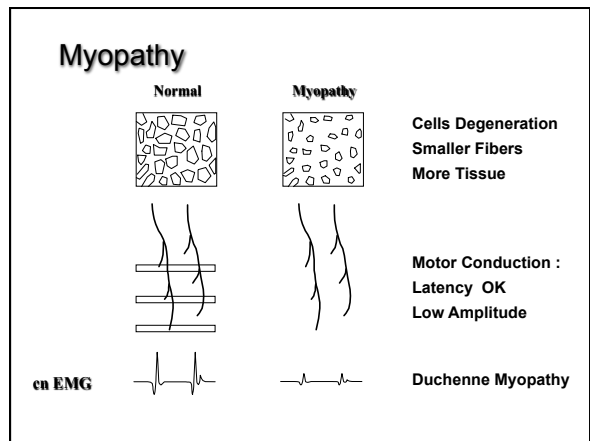
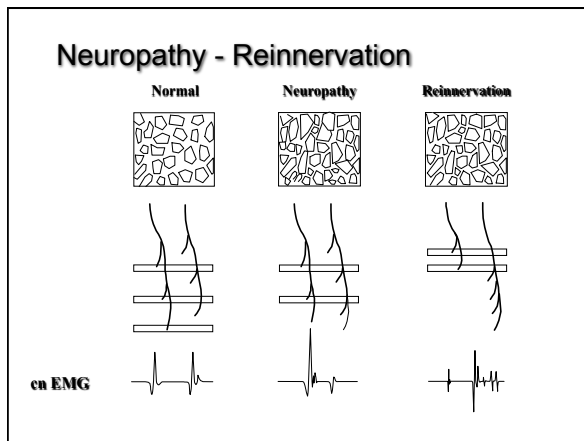
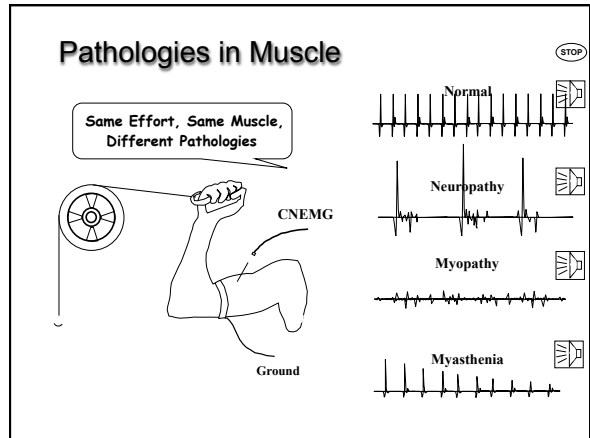
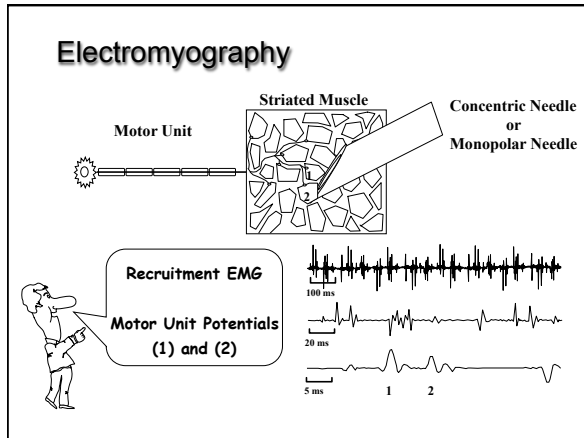
- ### Motor & Sensory *General Remarks*
- MOTOR**
- Amplitude minimum 1 mV - Direct response
 - Form normally biphasic
 - Duration 1 to 3 ms - Latency depend of stimulation site
 - Stimulation Current depend nerve and site, 15 - 30 mA
- SENSORY**
- Amplitude 5 μ V to 35 μ V
 - Indirect response - Averager needed
 - Direct response for high amplitude potentials
 - Form normally biphasic
 - Duration 1 to 3 ms - Latency depend of stimulation site
 - Stimulation Current depend nerve and site, 5 - 15 mA





ELECTROMYOGRAPHY

EMG - T/A - MUP - DECREMENT - SFU - MACRO




EMG - Recruitment

STOP

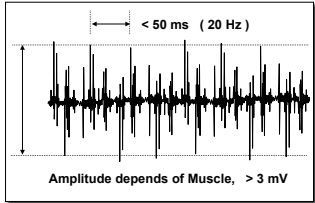
EMG Needles :

- Disposable Concentric
- Disposable Monopolar

MAXIMUM EFFORT



DCN EMG

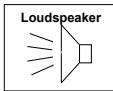


< 50 ms (20 Hz)

Amplitude depends of Muscle, > 3 mV

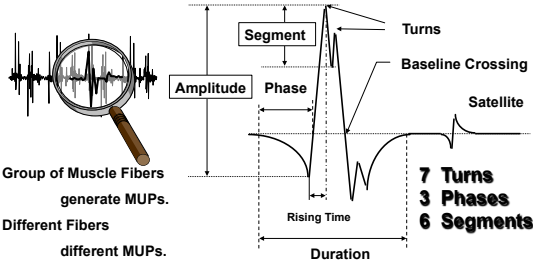
Auditory control of :

- Resting Silence
- Focused in the muscle
- Frequency Firing



Motor Unit Potential (MUP)

Single Potential, Phases ≤ 3
Polyphasic Potential, Phases > 3



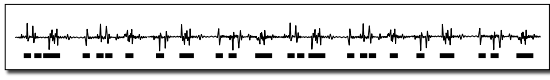
Group of Muscle Fibers generate MUPs.
 Different Fibers different MUPs.

Labels: Amplitude, Phase, Segment, Turns, Baseline Crossing, Satellite, Rising Time, Duration.

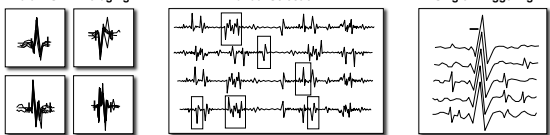
**7 Turns
3 Phases
6 Segments**

MUP Analysis


STOP



Multi-MUP - Averaging **Manual Selection** **Single - Triggering**

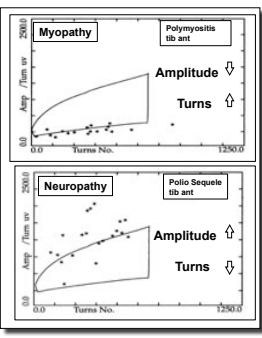


- Moderate Contraction
- Simple/Polyphasic Potentials Ratio
- Amplitude
- Duration



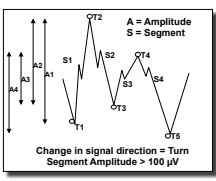
Turns/Amplitude

- 1 seconde EMG signal
- Concentric or Monopolar Needle
- Few sites in same muscle
- 20 mesurments at diff. force
- Number of Turns > 100 μV
- Mean Amplitude of Turns



Myopathy (Polymyositis tib ant): Amplitude \downarrow , Turns \uparrow

Neuropathy (Poliio Sequela tib ant): Amplitude \uparrow , Turns \downarrow



A = Amplitude
S = Segment

Change in signal direction = Turn
Segment Amplitude > 100 μV


Short Segments / Amplitude / Activity

- 500 ms EMG signal then x 2
- NSS Number of Small Segments
- UCA Upper Centile Amplitude

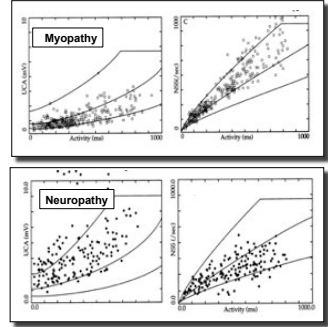
Small Segment

NSS	Amplitude	Duration
Yes	< 0,5 mV	< 1,5 ms
Yes	0,5 > < 2mV	< 3 ms
No	> 2 mV	< 5 ms

Activity

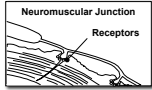


Sum of activity periods in % of full IP



Decrement

Neuromuscular Junction Receptors

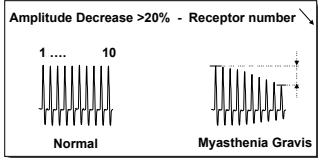


Acetylcholine Released

Myasthenia Gravis - Lambert-Eaton

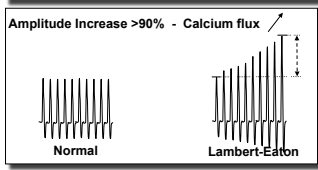
Amplitude Decrease >20% - Receptor number

1 ... 10



Normal Myasthenia Gravis

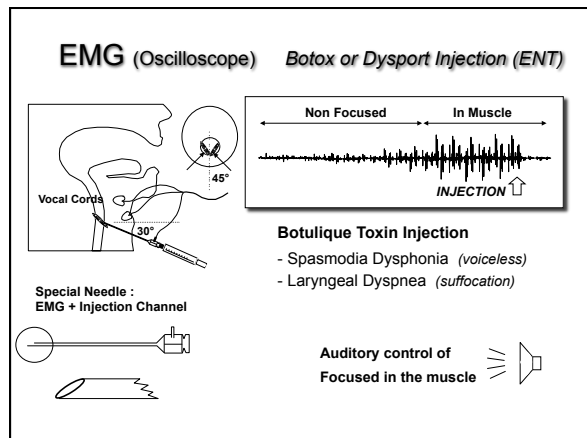
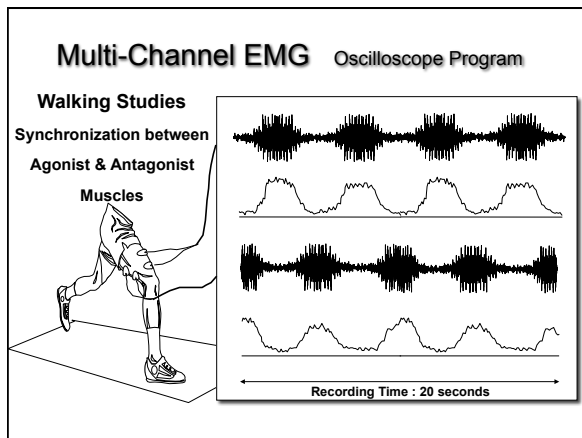
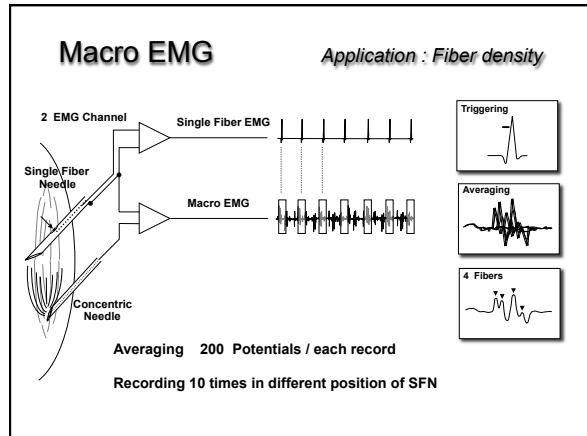
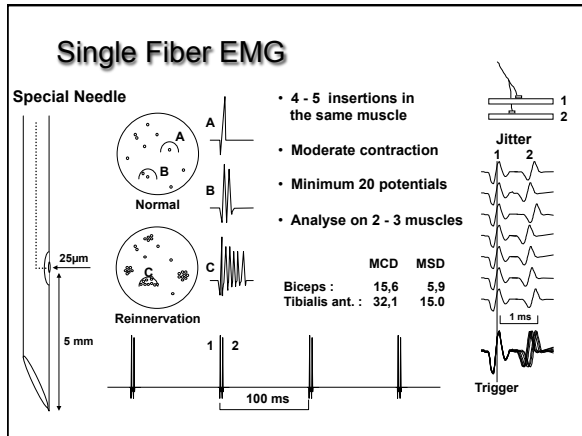
Amplitude Increase >90% - Calcium flux



Normal Lambert-Eaton

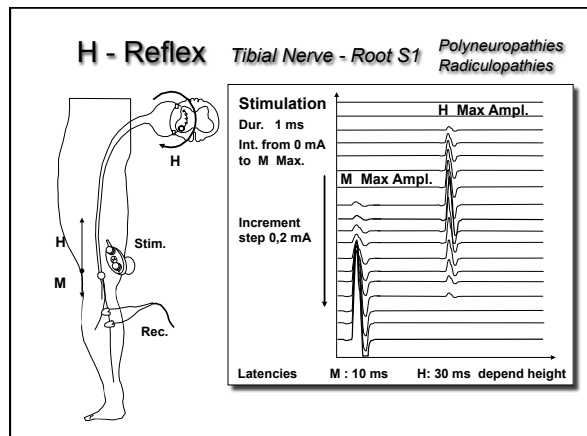
Stim. Rec.

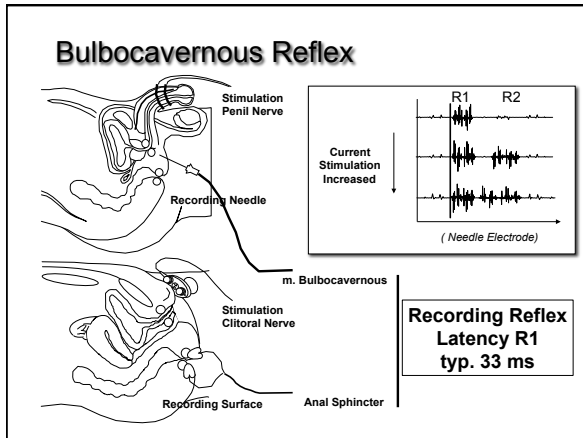
Stimulation : Supra Maximal + 25%
Train 10 Stimuli - Frequency 3 Hz



REFLEXES

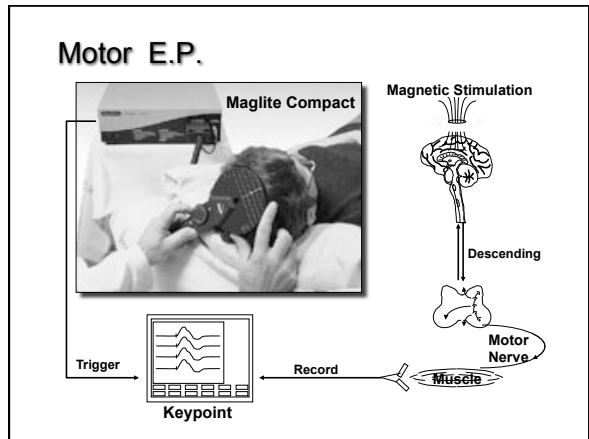
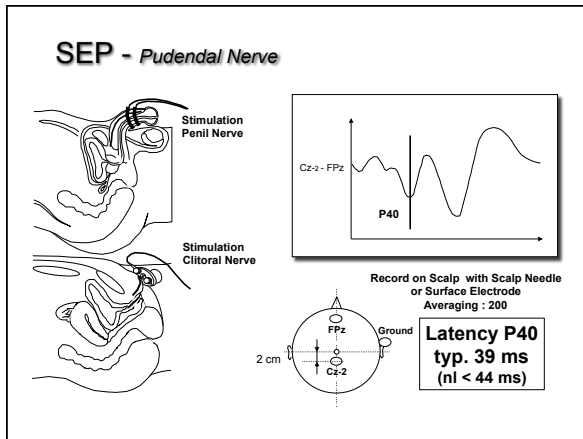
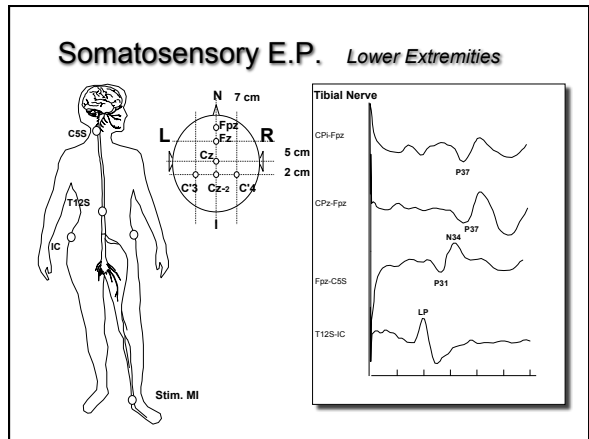
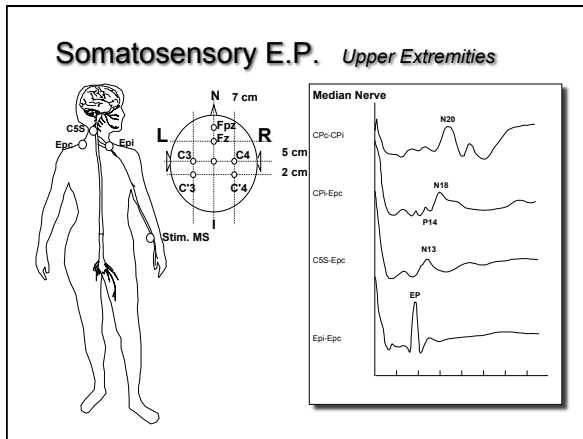
H - BLINK - T - BCR





EVOKED POTENTIALS

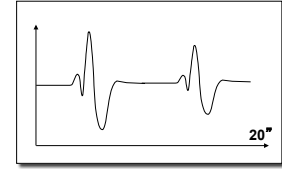
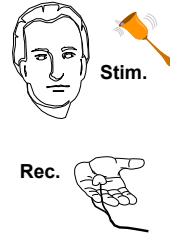
SEP - VEP - BAEP - AEP - P300 - MEP - IOM



AUTONOMIC

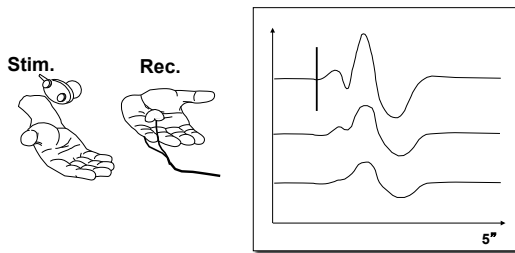
SSR - R:R INTERVALS - PELVIC

Sympathetic Skin Response *Autonomic*



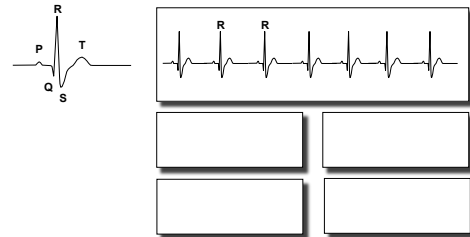
Free Running : Oscilloscope Program

Sympathetic Skin Response *Autonomic*

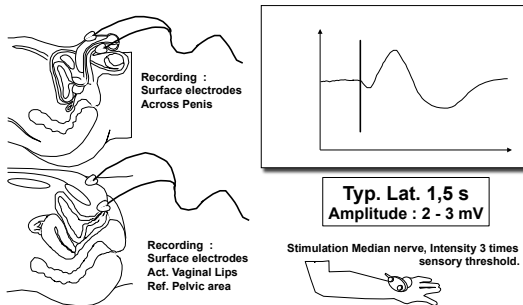


Synchronized Recording : Program SSR

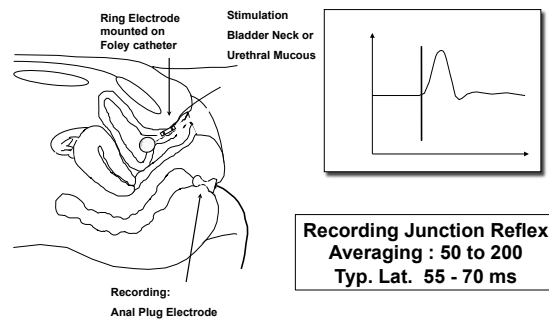
R - R Interval *Autonomic Heart Rate*



Pelvic SSR *Sexology Studies*



Autonomic Pelvic Responses *Sphincters*



Disposable EMG Needles and Cables

Disposable Concentric Needles - 25 pcs

□ Orange	9013S0011	25mm Ø 0.3mm
□ Green	9013S0021	25mm Ø 0.45mm
□ Blue	9013S0031	37mm Ø 0.45mm
□ Red	9013S0041	50mm Ø 0.45mm
□ Yellow	9013S0051	75mm Ø 0.45mm

Disposable Monopolar Needles - 48pcs

Ref. 9013R0801	20mm Ø 0.35mm
9013R0811	20mm Ø 0.35mm
9013R0821	30mm Ø 0.35mm
9013R0841	30mm Ø 0.45mm
Act. 9013R0851	40mm Ø 0.45mm
9013R0861	50mm Ø 0.45mm
9013R0871	60mm Ø 0.45mm
9013R0881	75mm Ø 0.45mm

9013C0011 Length 1 m
9013C0021 Length 2 m

9013P0812 Length 1 m
9013P0722 Length 76 cm

1.5 mm Female

Surface Electrodes Disposable

0.7mm

8 cm

GEL 9015B4111

Area 7 x 4 mm

9013L0202 Pack 50 pcs - Adhesive

9013S0211 Pack 12 pcs - Pre-Gelled Adhesive

8 cm

Area 20 x 15 mm

9013S0221 Pack 12 pcs - Pre-Gelled Adhesive
Neuro-Urology Active & Reference

15 cm

Area 20 x 15 mm

9021S0231 Pack 12 pcs - Pre-Gelled Adhesive
Neuro-Urology Ground

15 cm

Area 26 x 20 mm

9013S0241 Pack 12 pcs - Pre-Gelled "Blue Dot"

10 cm

Area 9 x 6 mm

1.5mm Female

50 cm

Area 9 x 6 mm

9013L0452 Pack 12 pcs - Pre-Gelled "Blue Dot"

9013S0231 Pack 100 pcs
CARE™ 610

Tab for Cable with Clip

Diam. 10 mm

™ CARE is a trademark of Kendall, Chicago, MA

Hush™ Cables and Electrodes

0.7 mm Connector

DIN Connectors

9013C0111 Length 1 m
9013C0121 Length 2 m

9013C0131 Length 1 m
9013C0141 Length 2 m

9013C0211 Length 1 m
9013C0221 Length 2 m

9013C0231 Length 1 m

Clip Connector

9013L0202

9013S0211

9013S0241

9013R0312

9013L0701

9013L1701
Disposable Sensory Needle

Autoclavable Sensory Needle

9013S0231