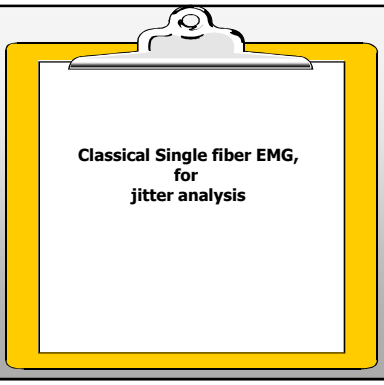
S F EMG.Info

Jitter recordings with concentric needle electrode

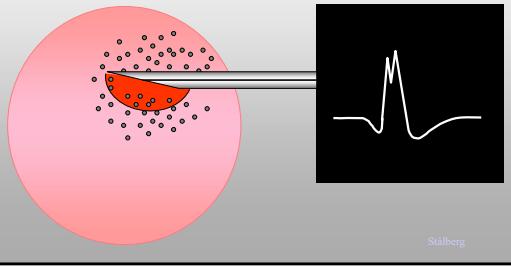
Erik Stålberg

Most of the voluntary signals are recorded by Stålberg
All stimulation signals are recorded by Kouyoumdjian (shown with permission)

45

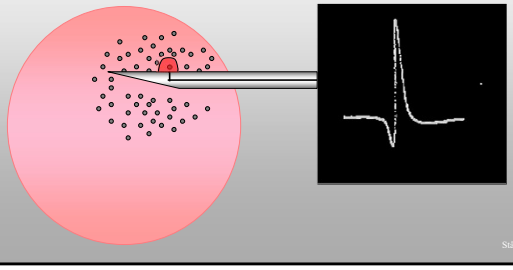


CNEMG
signal from 2-15 muscle fibres



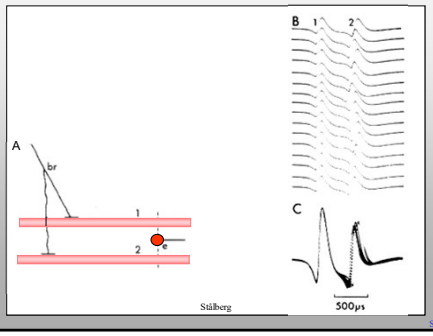
Stålberg

SFEMG (Single Fibre EMG)
signal from 1 muscle fibre



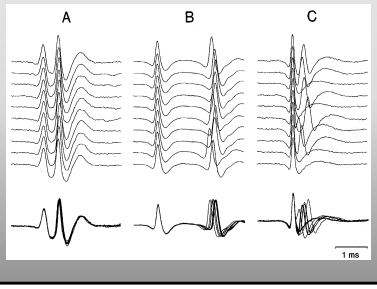
Stålberg

SFEMG; jitter



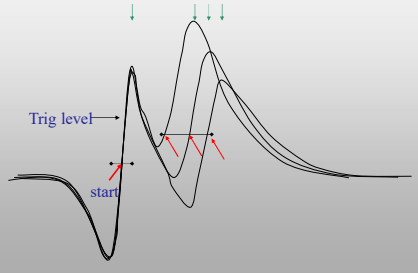
Stålberg

Single fiber action potentials in MG volitional activation



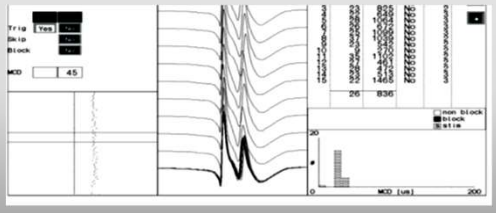
Stålberg

Jitter measurement at amplitude levels vs peaks in riding signals



Stålberg

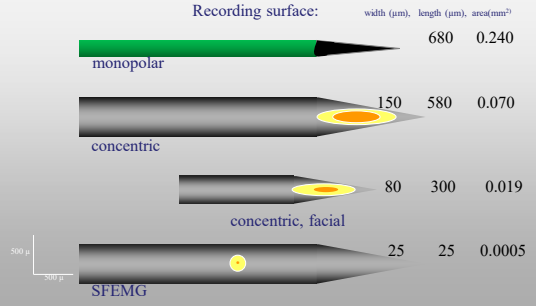
Jitter display: peak trigger



Measuring jitter with

Concentric Needle electrodes

Four types of EMG electrodes

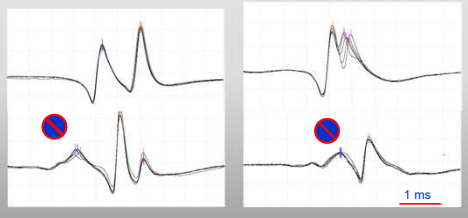


Definitions of acceptable CNE signals for jitter analysis

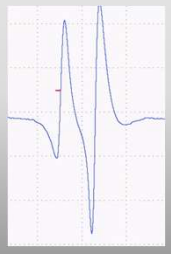
- Positive-negative signals without inflections, notches or shoulders.
- Parallel rising segments upon superimposition (5-15)
- Negative peaks should be separated by more than 150 usec
- Allow only slight amplitude variation in the signal, else summation from same MU or background activity
- Amplitude > 50uV

Jitter recordings with Conc el.

Facial needle, 1000Hz-10KHz

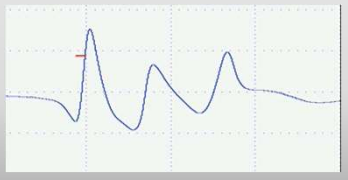


SFEMG



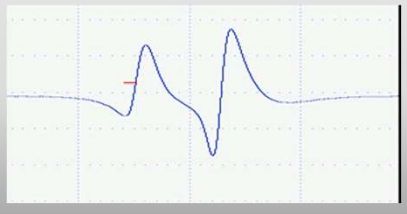
ana4

Jitter with conc needle electrode

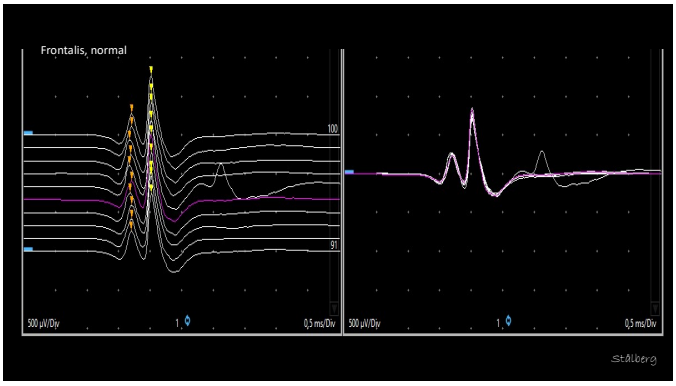


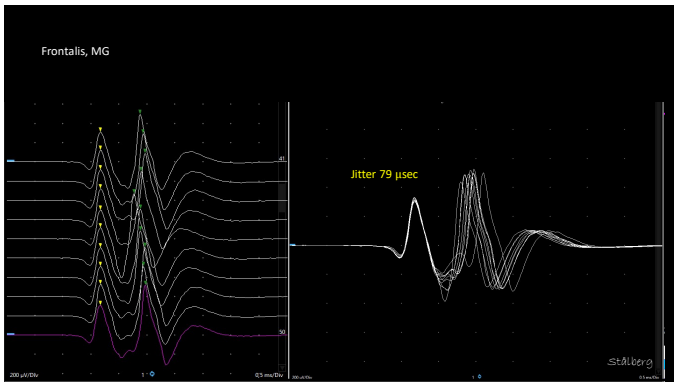
concentric2

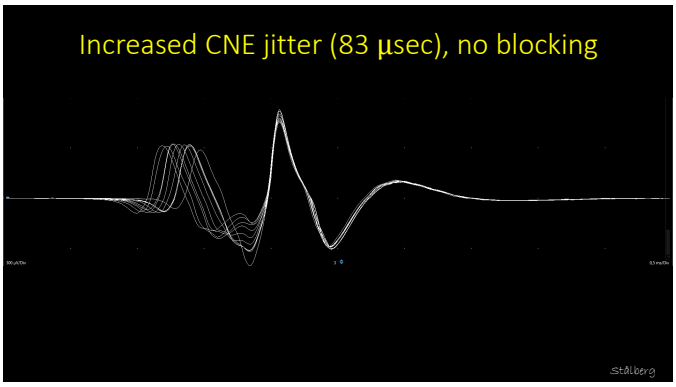
Jitter with conc needle electrode acceptable

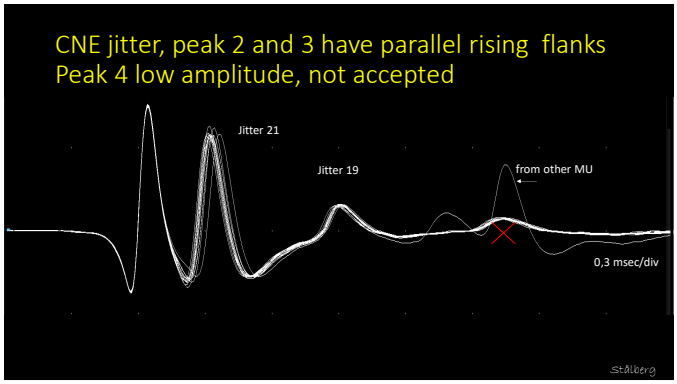


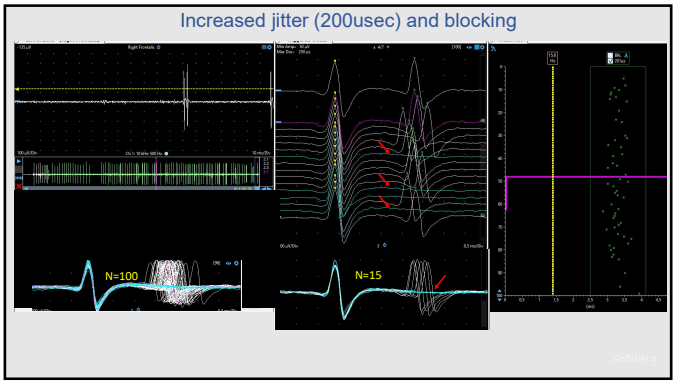
concentric4



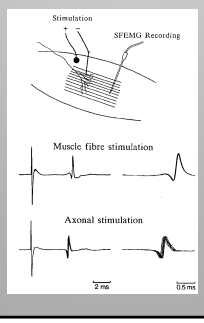

Frontalis, MG
Jitter 79 µsec
Stålberg


Increased CNE jitter (83 µsec), no blocking
Stålberg

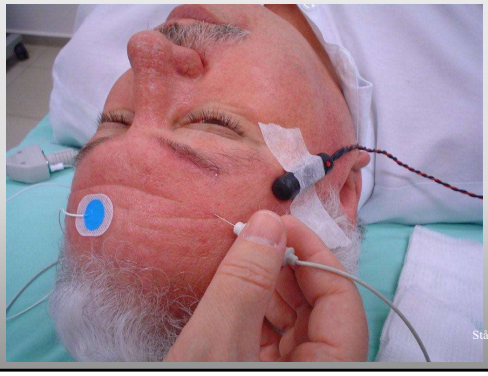

CNE jitter, peak 2 and 3 have parallel rising flanks
Peak 4 low amplitude, not accepted
Jitter 21
Jitter 19
from other MU
0,3 msec/div
Stålberg


Increased jitter (200usec) and blocking
N=100
N=15

Intramuscular stimulation and SFEMG recording

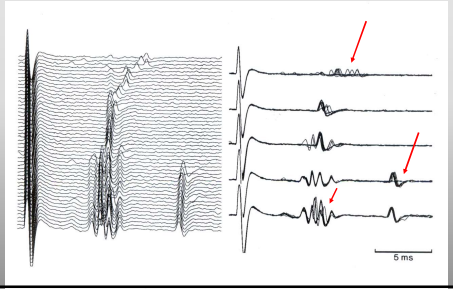


Stålberg

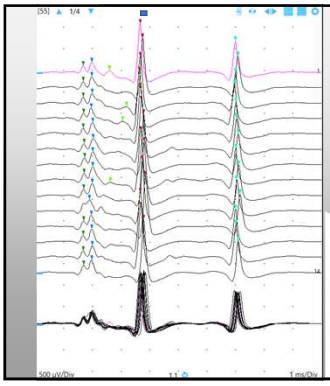


Stålberg et al, 2010

Axonal stimulation, increasing stim strength. Note increased jitter at liminal stimulation

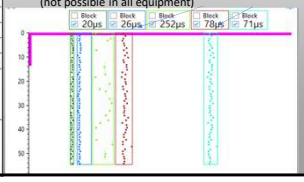


Increasing stim strength

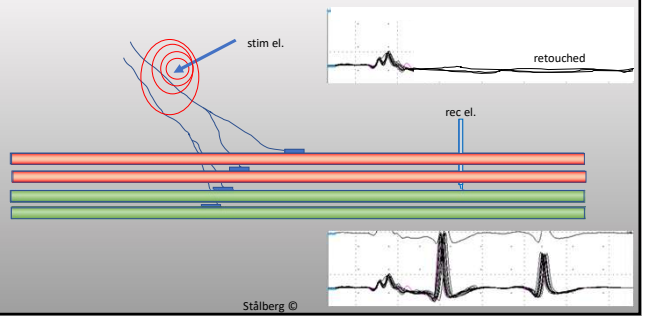


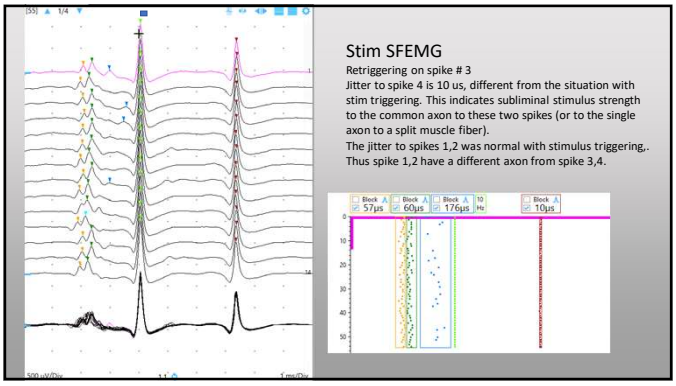
Stim SFEMG

Triggering on the stimulus
Note the jitter in the last 2 spikes, 78 and 71 us.
The dot plot pattern shows parallel shifts for these two spikes, but not for the first two spikes.
If the jitter is independent, the jitter between them should be $v78^2+71^2$ = 105 usec
Two strategies to proceed
1. increase stim strength – with the risk of activating new axons
2. trigger on one of the spikes with common shifting
   (not possible in all equipment)

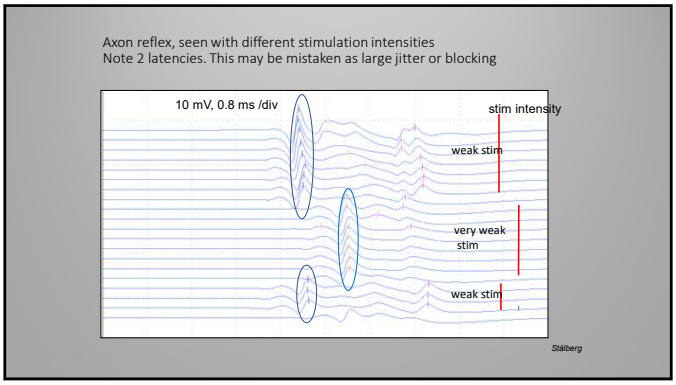


Subliminal axonal stimulation



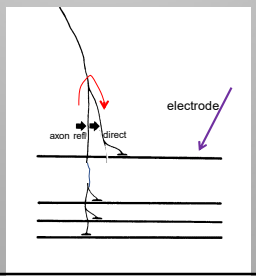


An other pitfall, the axon reflex



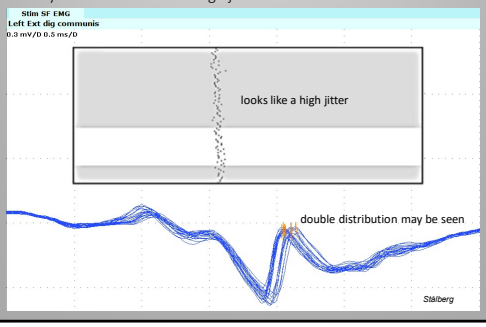
Axon reflex

Weak stimulation, gives retrograde activation of the recorded fiber.
Stronger stimulation gives direct activation. This gives dual latencies.



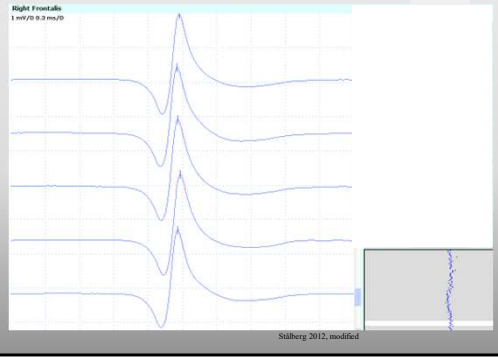
Stålberg

Axon reflex; note the dual distribution of latencies
- small latency differences difficult to detect and therefore the recording is falsely considered to have large jitter

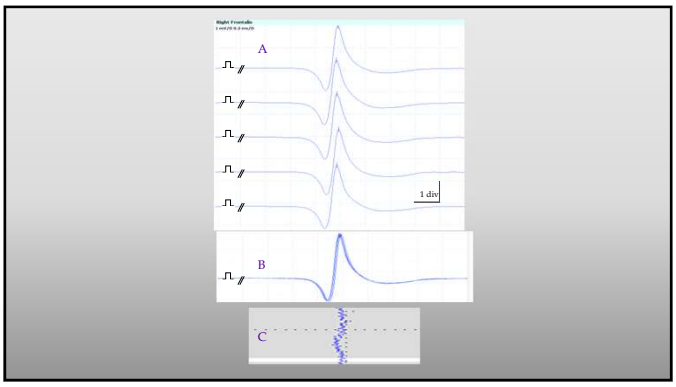


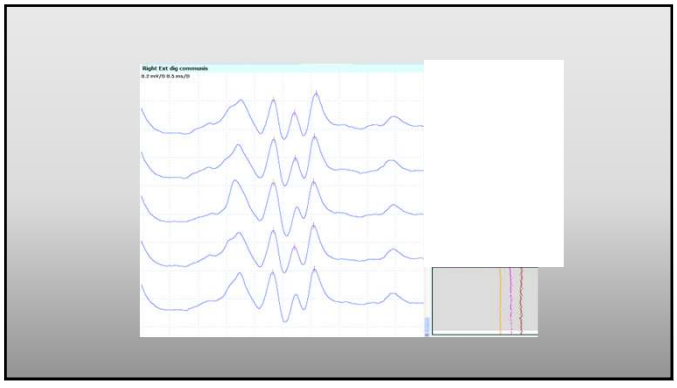
The recording; practical hints

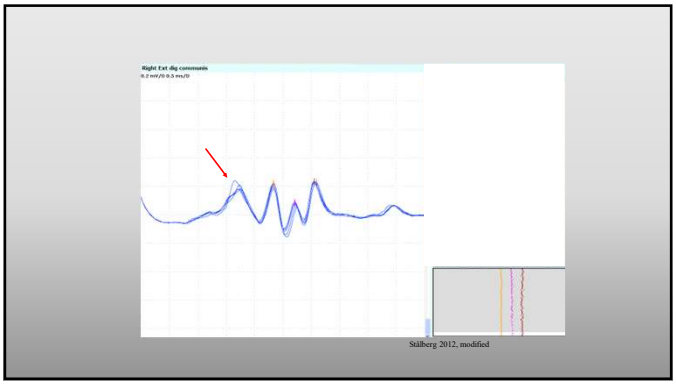
ELECTRICAL STIMULATION
Needle or surface electrode for stimulation, 5-10Hz
Insert the CNE into twitching muscle part
Use slight stimulus intensity, to get few spikes
Make sure that the spike of interest, is supraliminally stimulated
If a spike shows abnormal jitter, increase the stim. intensity a little
Measure jitter between stimulus and spike/s in focus



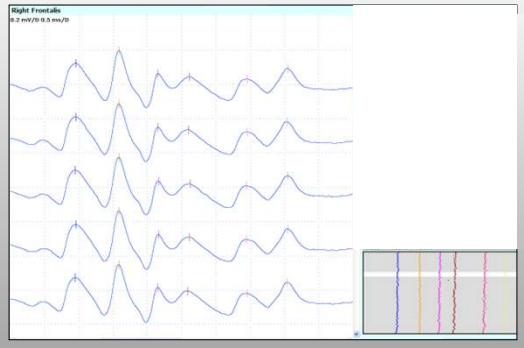
Stålberg 2012, modified

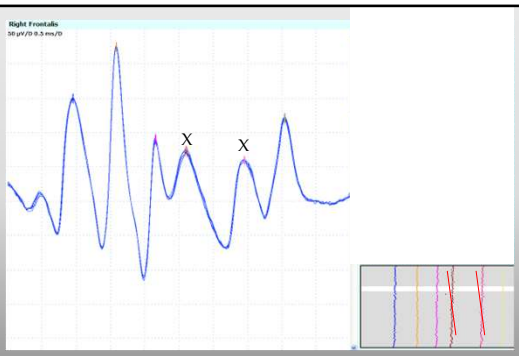

A
1 div
B
C

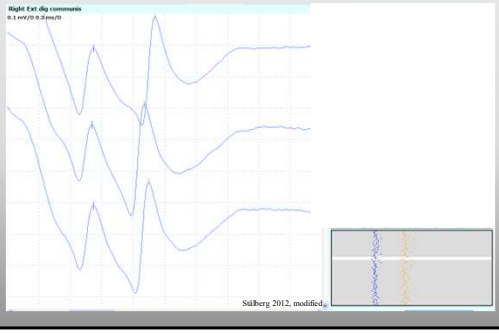



Stålberg 2012, modified

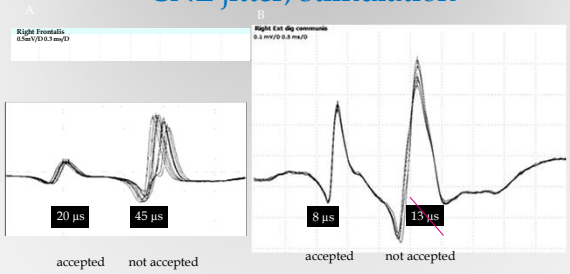
Stimulation







CNE jitter, stimulation



Jitter with CNE

Muscle	Mean MCD limit µs	Individual data limit µs
OO vol	31	45
OO stim	27	36
Frontalis vol	28	38
Frontalis stim	21	28
Ext dig vol	30	43
Ext dig stim	24	35

Stålberg et al. Multicenter study, 2015

NOTE

Increased jitter or abnormally decrementing response on RNS are not equal to MG but usually a sign of disturbed nm transmission (as in reinnervation)

Amplifier settings:

Filter: CNE for jitter analysis 1kHz-10kHz

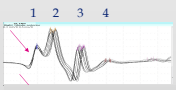
Sweep speed: 0,5 msec/div (always less than 2 msec/div)
Gain: not crucial. Make signals to cover about 2 divisions

For quality control during and after recording, superimpose 5-15 sweeps

Influence of triggering spike on jitter value (volitional)

ALS

Arrow indicates chosen trigger

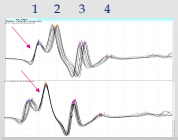


1_2	1_3	1_4	jSUM
48.8	46.1	94.2	189.1

Influence of triggering spike on jitter value (volitional)

ALS

Arrow indicates chosen trigger

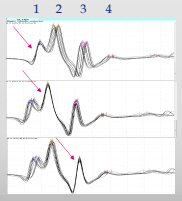


1_2	1_3	1_4	jSUM
48.8	46.1	94.2	189.1
2_1	2_3	2_4	
48.8	34.6	92.2	175.6

Influence of triggering spike on jitter value (volitional)

ALS

Arrow indicates chosen trigger

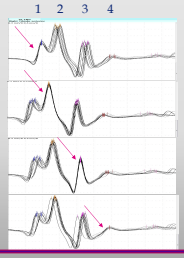


1_2	1_3	1_4	jSUM
48.8	46.1	94.2	189.1
2_1	2_3	2_4	
48.8	34.6	92.2	175.6
3_1	3_2	3_4	
46.1	34.6	91.3	172.0

Influence of triggering spike on jitter value (volitional)

ALS

Arrow indicates chosen trigger



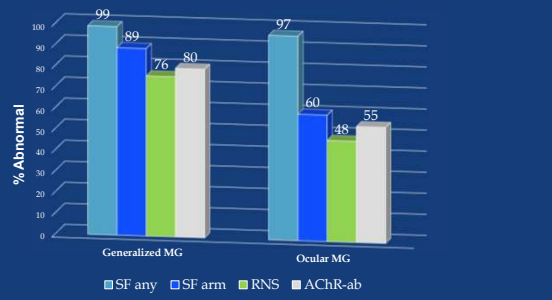
1_2	1_3	1_4	jSUM
48.8	46.1	94.2	189.1
2_1	2_3	2_4	
48.8	34.6	92.2	175.6
3_1	3_2	3_4	
46.1	34.6	91.3	172.0
4_1	4_2	4_3	
94.2	92.2	91.3	277.7

Sum of jitter values = jSUM. Optimal reference when jSUM is minimum, in this case trigger on spike 3
Spike 4 not useful because of low amplitude

Sensitivity

The degree of increased jitter in the diagnosis of MG is similar for the SFEMG and CNE methods

Sensitivity of Initial Tests in 550 Untreated MG Patients



Sanders, Massey & Howard 1996

Frequently asked questions

Q: Can we measure FD with CNE?

A: no, too large uptake area, go for MUP parameters

Q: Which muscles to use in MG diagnosis?

A: symptomatic muscles. Often orb oculi and frontalis

Q: what about Botox

A: Remote effects cause jitter in many muscles. Effect remains for long time; 3-6 months

Q: if jitter is normal in OO with ptosis which is the interpretation

A: Ptosis = weakness. If due to MG, the jitter MUST be increased + impulse blocking. If normal, consider alternate diagnosis

Links

www.erikstalberg.com (for this and other EMG videos)

www.sfemg.info (for SFEMG material including videos)

Poem on SFEMG
St Gallen April 1, 2023

Author RB and ES + more

In the depths of muscle, unseen
Lies a junction, strong and keen
Where nerve meets fiber, hand in glove
Ready to send its message of love

But what if this connection fails?
What if the muscle's strength pales?
Single Fiber EMG can help us see
The issues that lie beneath the knee

With electrodes and needles, we explore
The fibers that make muscles move
And through the signals that they send
We find the truth, where troubles end

Myasthenia gravis, Lambert-Eaton too
All can be diagnosed with this view
Of the neuromuscular junction's might
And the fibers that make it bright

So let us praise this test divine
For the insights it gives us, line by line
Into the workings of muscle and nerve
And the secrets that they preserve.