Electrophysiological approaches to compression and entrapment neuropathies

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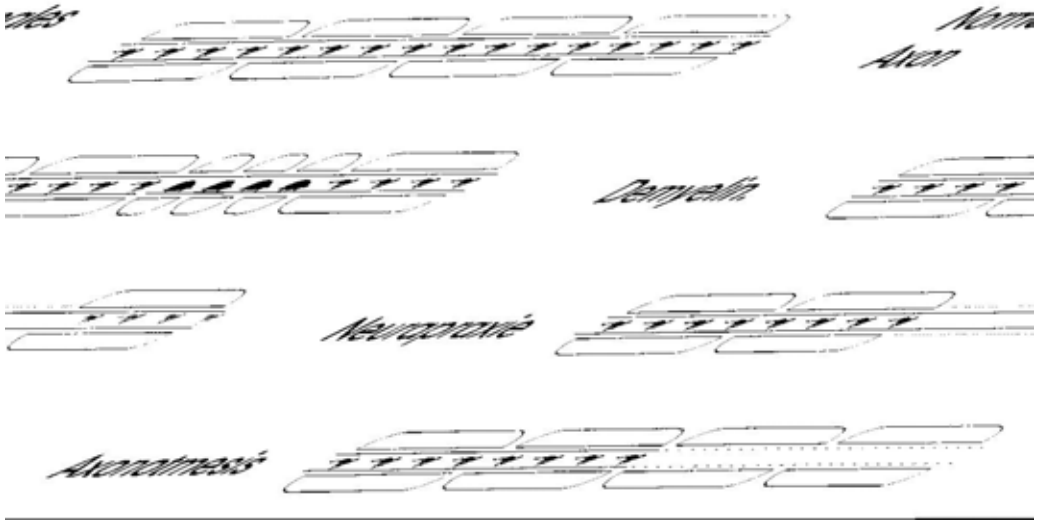
Aims of EDX testing in nerve compression/entrapment

- Provides information on:
  - Localization
  - Motor, sensory or mixed involvement subclinical nerve damage
  - Axonal, demyelinating injury or both
  - Severity can be assessed
    - Neuropraxia;axonotmesis; neuronotmesis
  - Prognosis can be estimated

- Effect of treatments may be quantitated

Type of compression

- Acute compression
  - conduction block
  - axonal loss
- Chronic entrapment
  - demyelination
  - axonal damage



Techniques

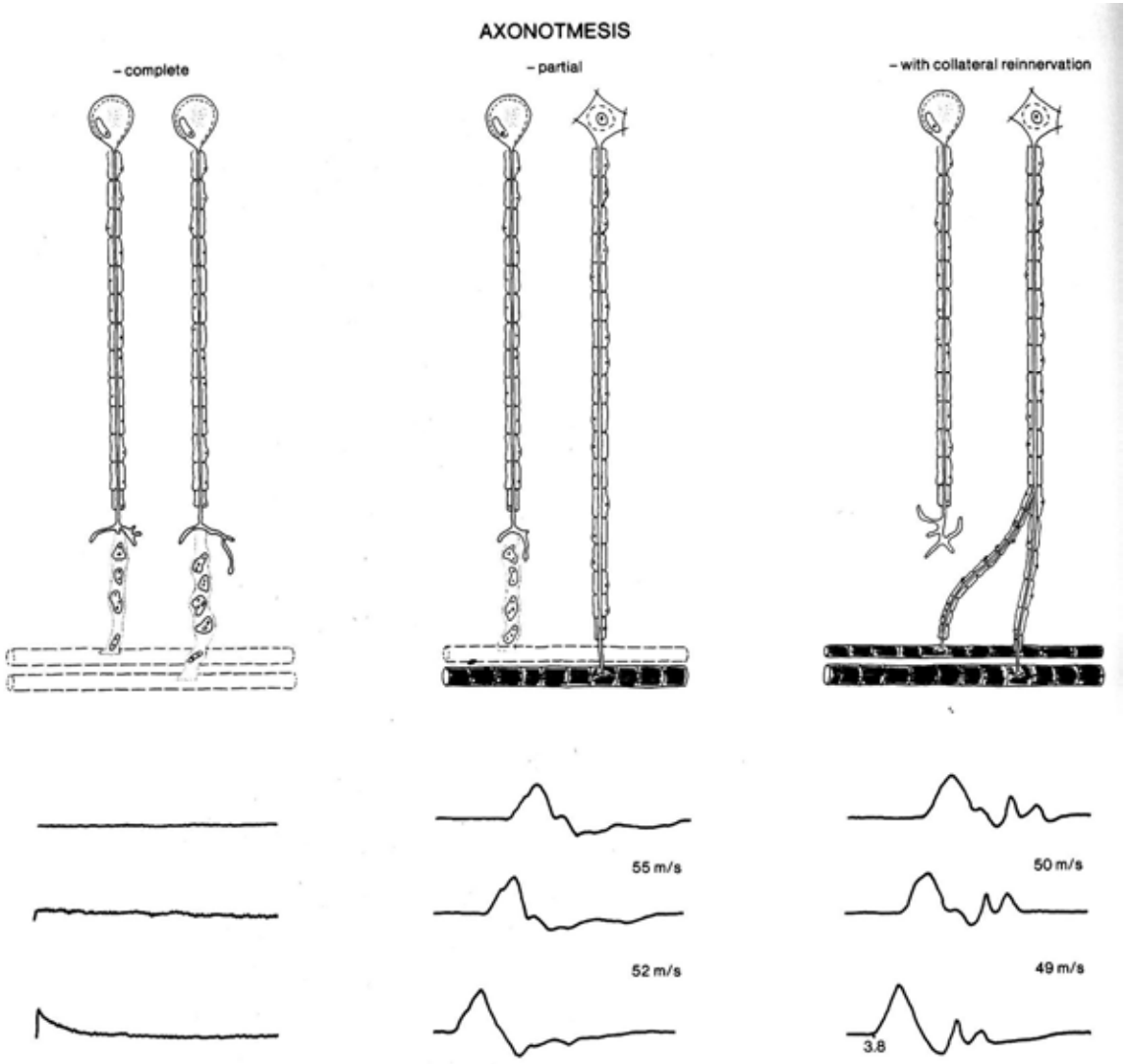
- Neurography
  - Nerve conduction studies (motor/sensory)
    - Conduction block
    - myelin problems
  - F-wave studies
    - proximal conduction
- Electromyography
  - loss of motor units
  - axonal degeneration and regeneration
  - time course of an axonopathy
  - early reinnervation

Pathophysiology of nerve lesion

Axonotmesis

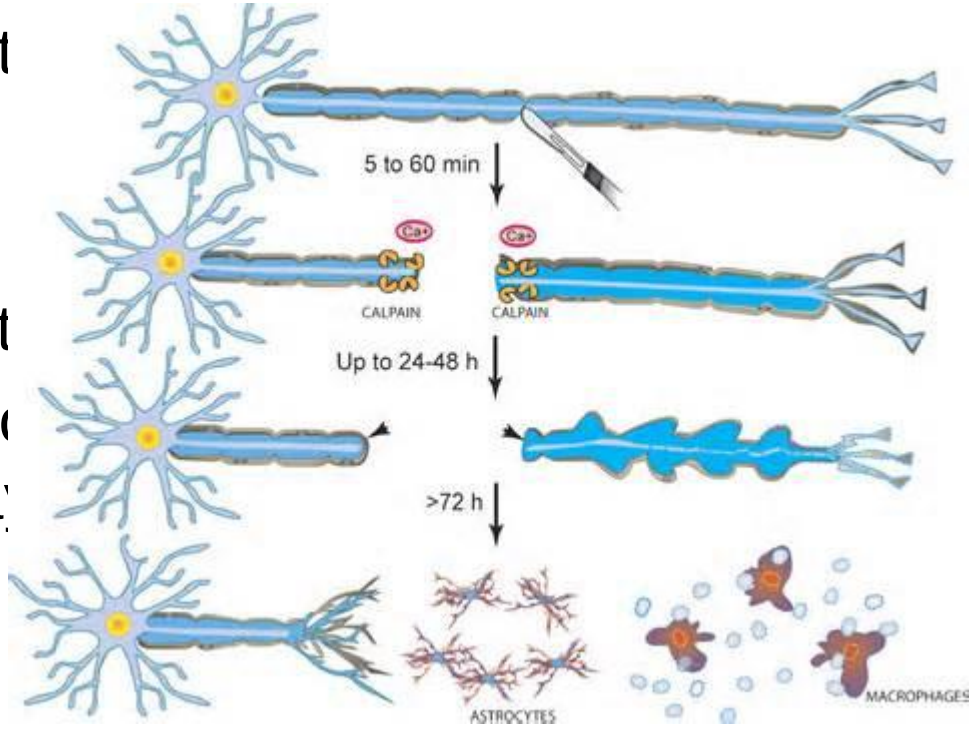
- Disruption of the axon and myelin sheath
- Supporting and connective tissue spared
- Recovery
  - May be minimal, incomplete or full
  - Dependent upon severity and length of nerve injured
  - Via axonal sprouting and regeneration
    - Growth rate of about 1-3 mm/day
  - In partial axonotmesis collateral reinnervation starts very early
  - Crush, stretch most common causes
  - Slow recovery, usually months

Seddon types



Neuronal Degeneration

- Distal to Injury Site
  - Follows axonal transection
  - Due to isolation of distal nerve segment from cell body
  - Wallerian degenerat
- Proximal to Injury Site
  - Degeneration back t
  - If very proximal, chr
    transected axon ma



EDX findings

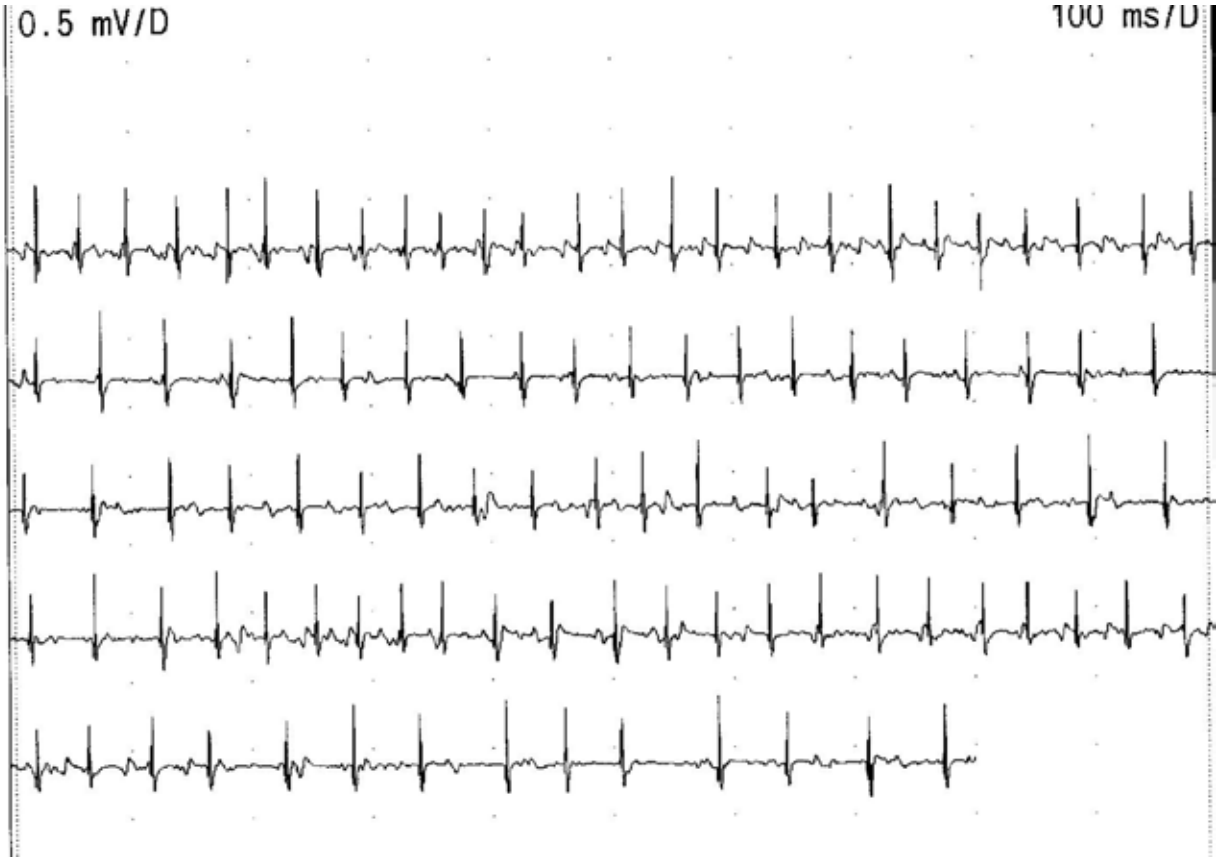
- Conduction studies are not specific and usually not useful to localize the damage
- Concentric needle EMG is essential in the diagnosis of an axonopathy
- It is helpful
  - to localize the lesion
  - to estimate to time course
- Findings depend on the
  - severity (number of axons affected)
  - timing of the entrapment (new, repeated)

Time course of EMG findings in (partial) axonopathies

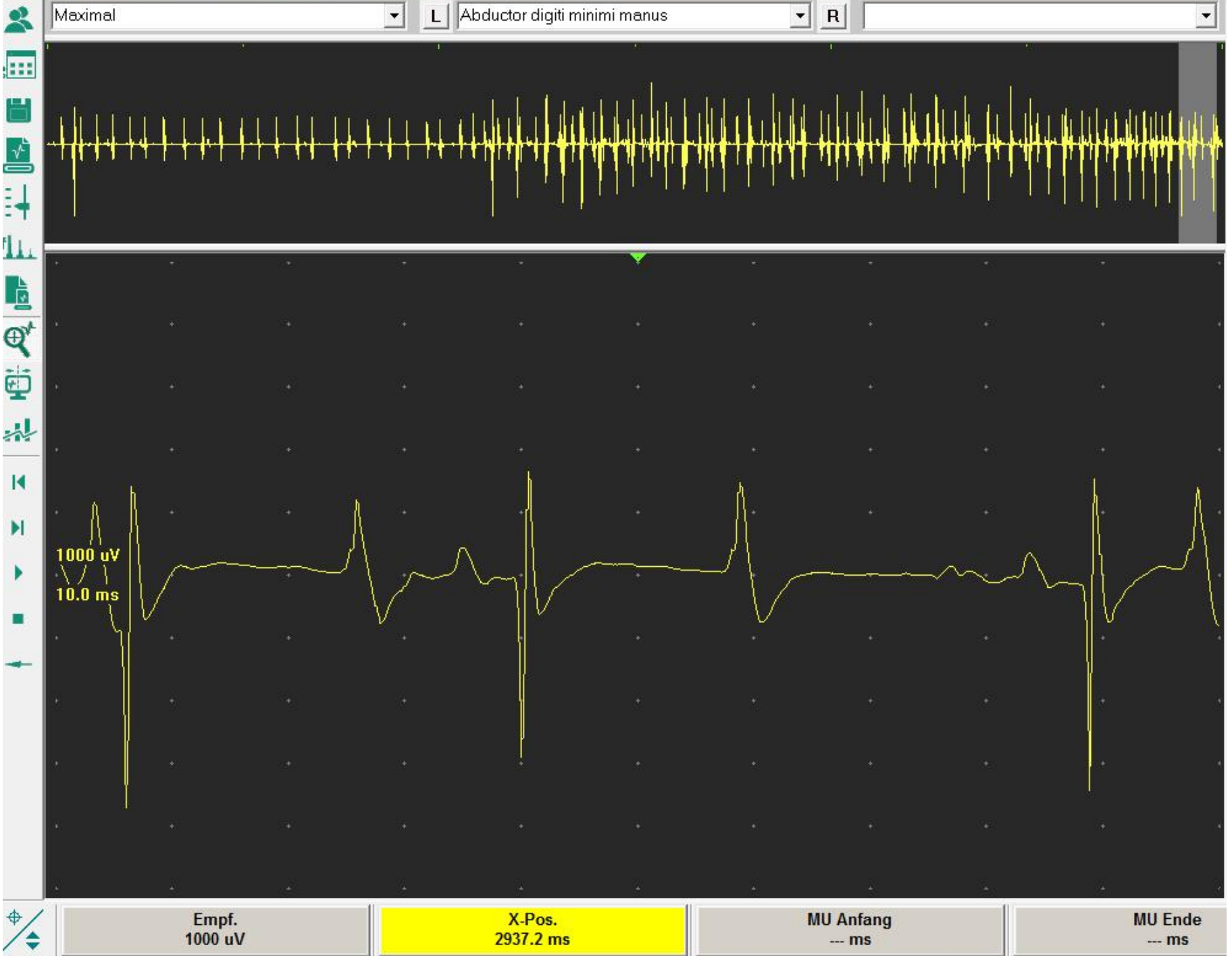
week	fibs	amplitude	polyphasic	satellite	discharge frequency
0-2	-	normal	none	none	>20Hz
3-6	++	normal	none	none	>20Hz
6-12	++	normal	few	yes	>20Hz
12-36?	+	increasing	many	rare	(>20Hz)
old	(+)	high	few	none	variable

Within the first 2 weeks conduction block and axonopathy have the same EMG findings

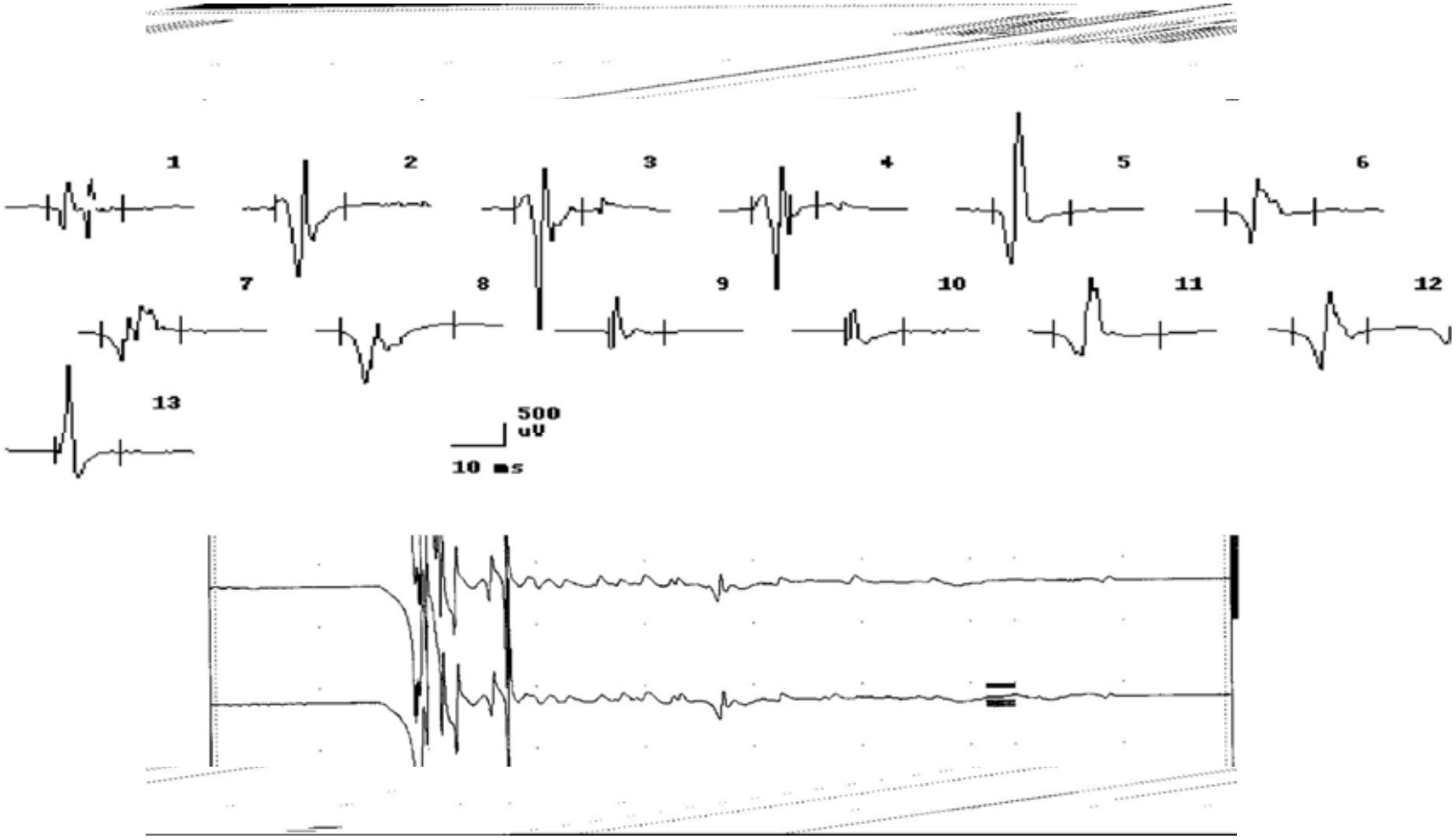
MUP discharge frequency



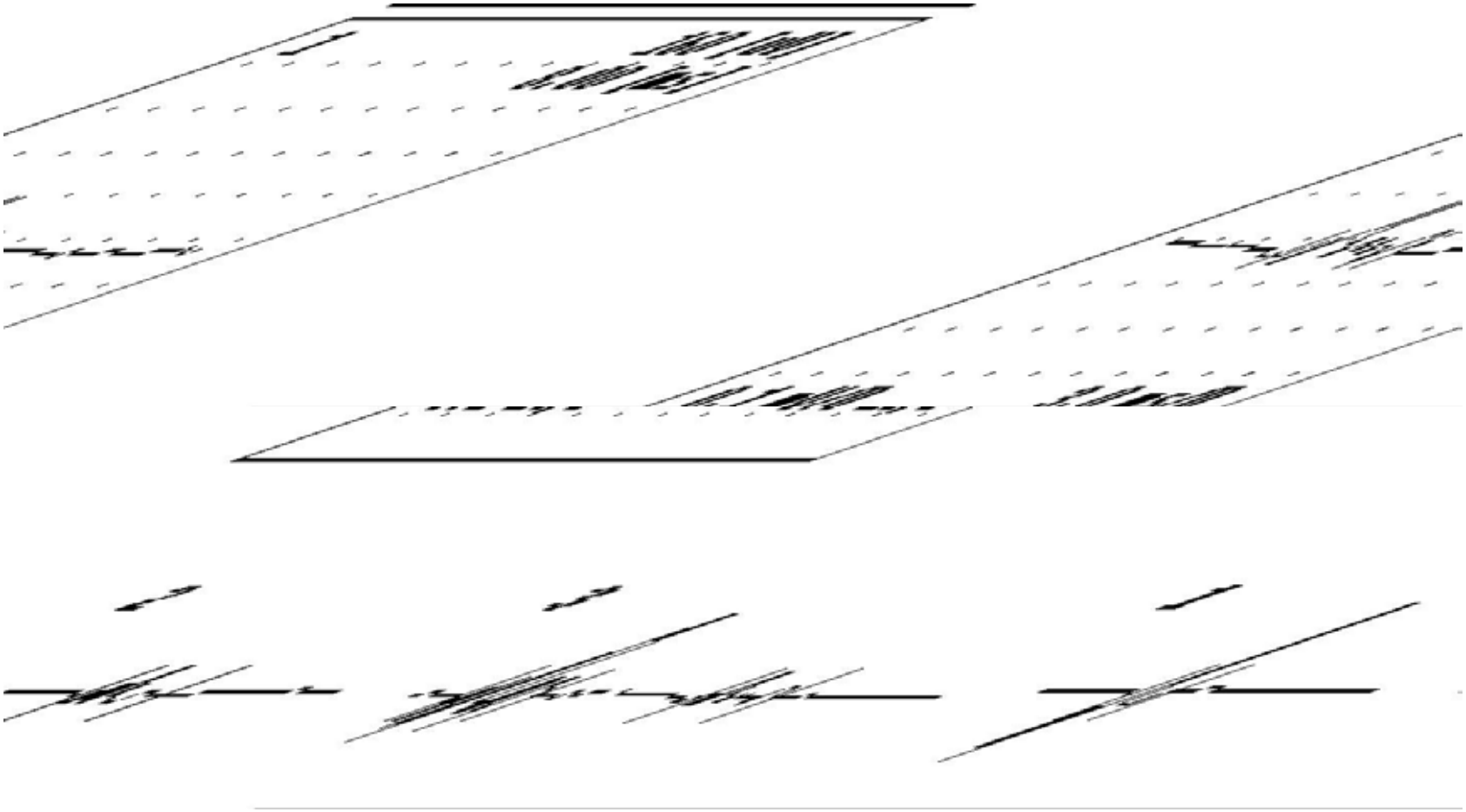
Discharge frequency does never differ between cb and axonopathy


Maximal
L
Abductor digiti minimi manus
R
1000 uV
10.0 ms
Empf.
1000 uV
X-Pos.
2937.2 ms
MU Anfang
--- ms
MU Ende
--- ms

Partial axonopathy
collateral reinnervation

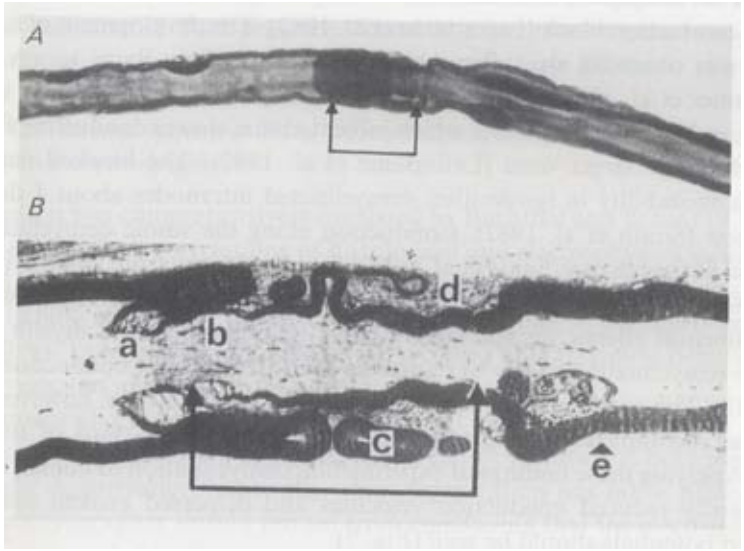


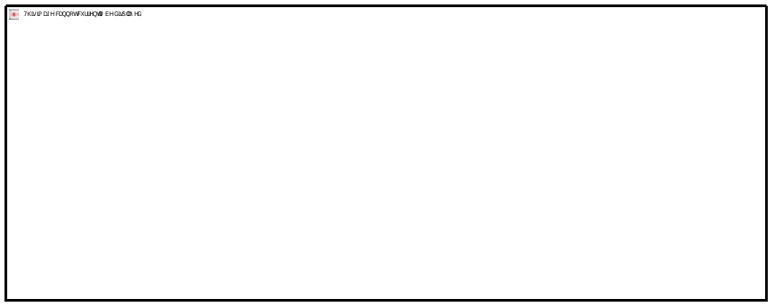
Total axonopathy
early reinnervation



Conduction block

- Nerve conduction is normal proximal **and** distal to the compression but there is no conduction across the lesion
- Axonal damage can be differentiated
  - after 1 week by conduction velocity studies
  - after 2 weeks by EMG too





Ochoa 1972

Pathophysiology of nerve lesion

Neuroapraxia – conduction block

- Mildest type of nerve compression
- usually transient disruption of nerve function
- Ischemic, metabolic or microstructural abnormalities
- Axonal integrity maintained
- REVERSIBLE failure of nerve conduction
- Most often compressive/ischemic
- Normalizes within hours to weeks (months)

Conduction block

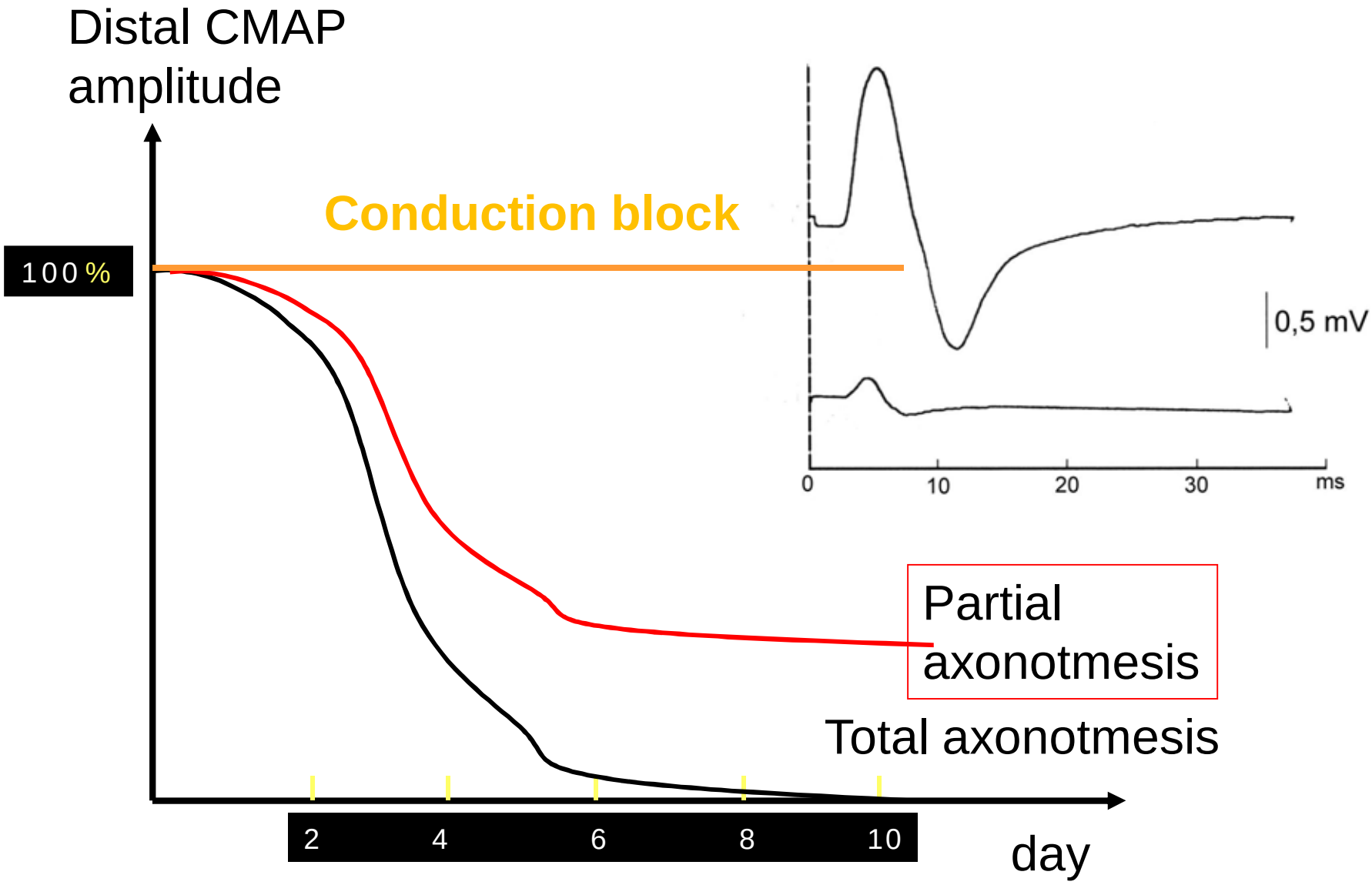
- Acute due to compression
  e. g. radial nerve
  peroneal nerve
- Special situations: distal and very proximal conduction block
- „chronic“ conduction block in patients with MMN
- Hereditary liability to pressure palsy

partial conduction block

- Clinical signs of weakness can only be found when >60% of nerve fibres are damaged
- Using EDX it may be found earlier
- Motor CB are better defined than sensory CB
- Short segment stimulation is the most reliable procedure
- EMG is normal, no fibs, normal MUP,
  except discharge rate of motor units may be >20/s

(as it is in weak muscles due to conduction block)

Time course of amplitudes



Criteria

	No signs of temporal dispersion	CMAP duration increases by <30%	CMAP duration increases by 30-60%
	Definite CB	Possible CB	Possible CB
Median nerve	50%	40-49%	>50%
Ulnar nerve	50%	40-49%	>50%
Radial nerve	n.d.	>50%	>60%
Peroneal nerve	>60%	50-59%	>60%
Tibial nerve	>60%	50-59%	>60%

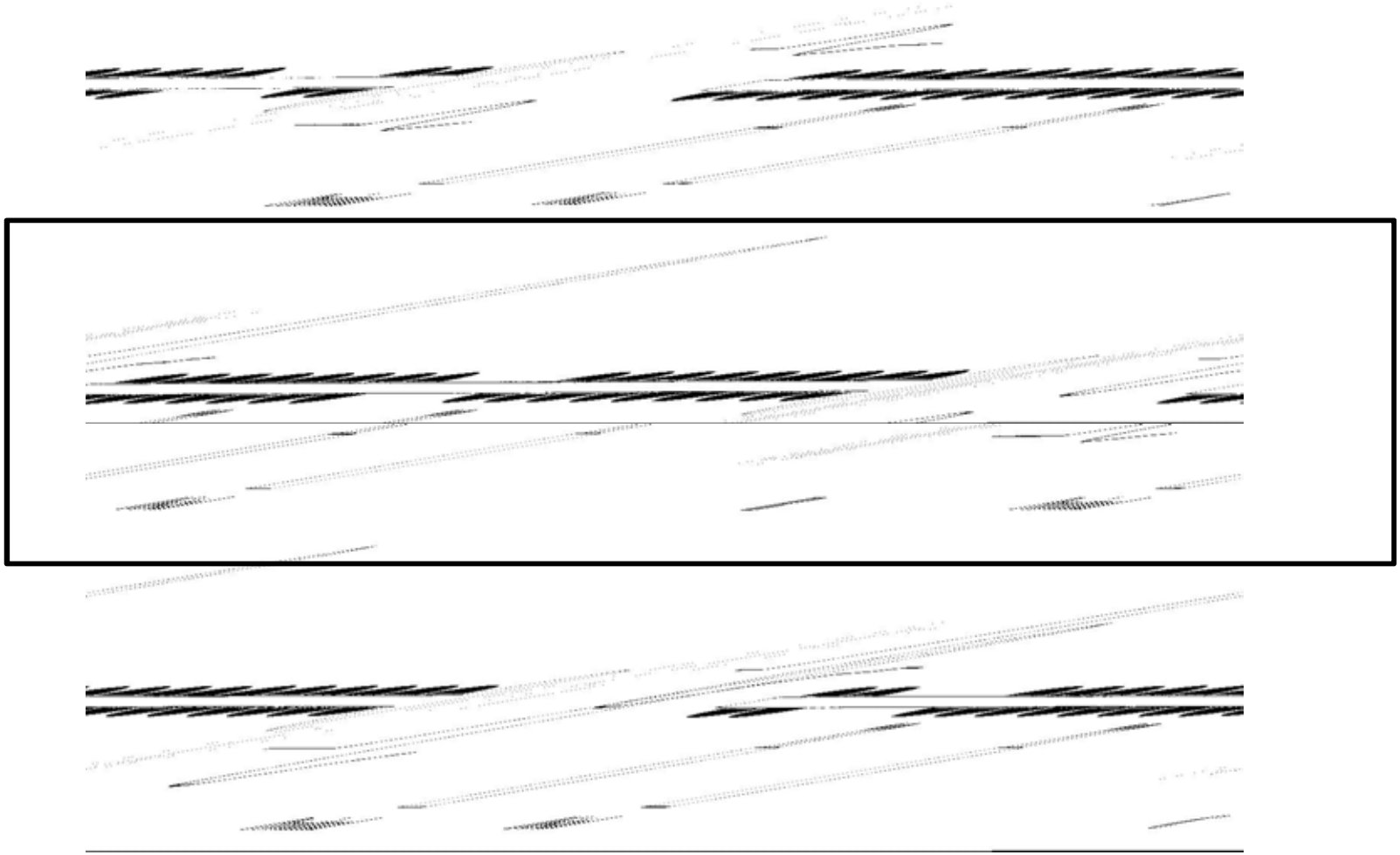
Amplitude >20% of LLN

Pitfalls

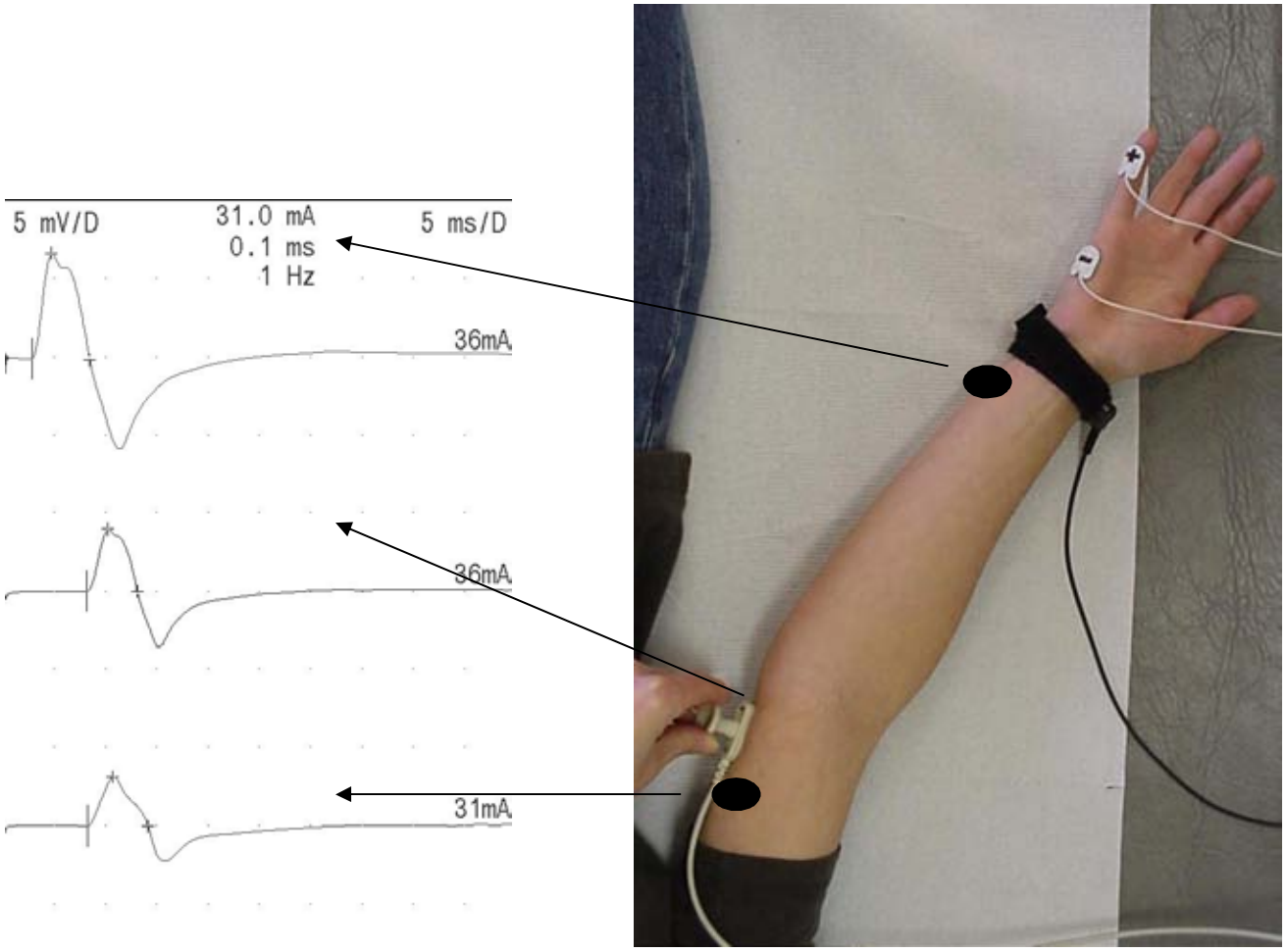
- Anatomical
  - Localisation
  - anastomosis
- Differentiation between conduction block and axonopathy

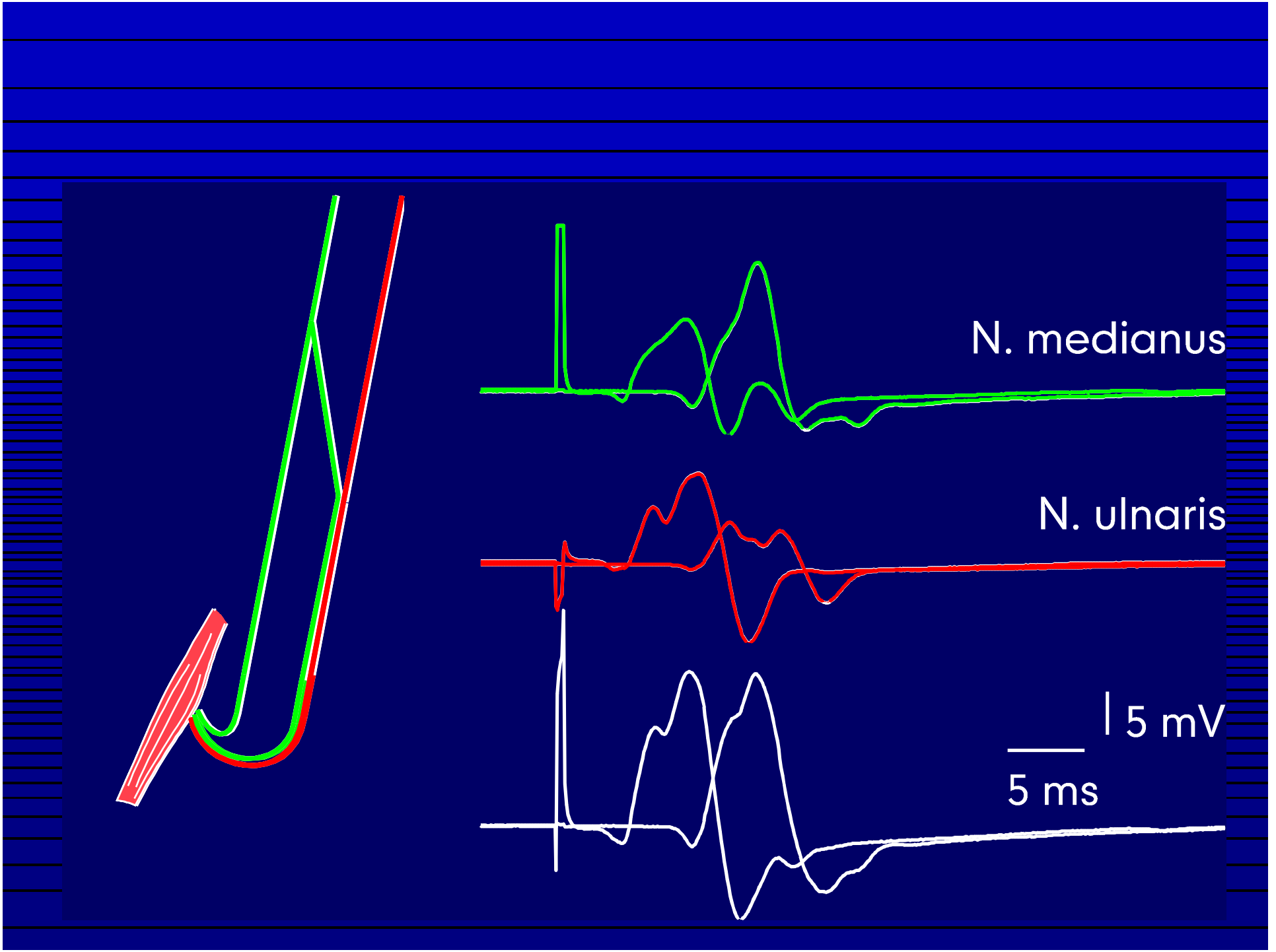
- Technical
  - submax stimulation
  - measurement error
  - temperature
  - latency measurement
    - amplification
    - positive deflections of the potential

Pitfalls due to the distal localisation of a conduction block

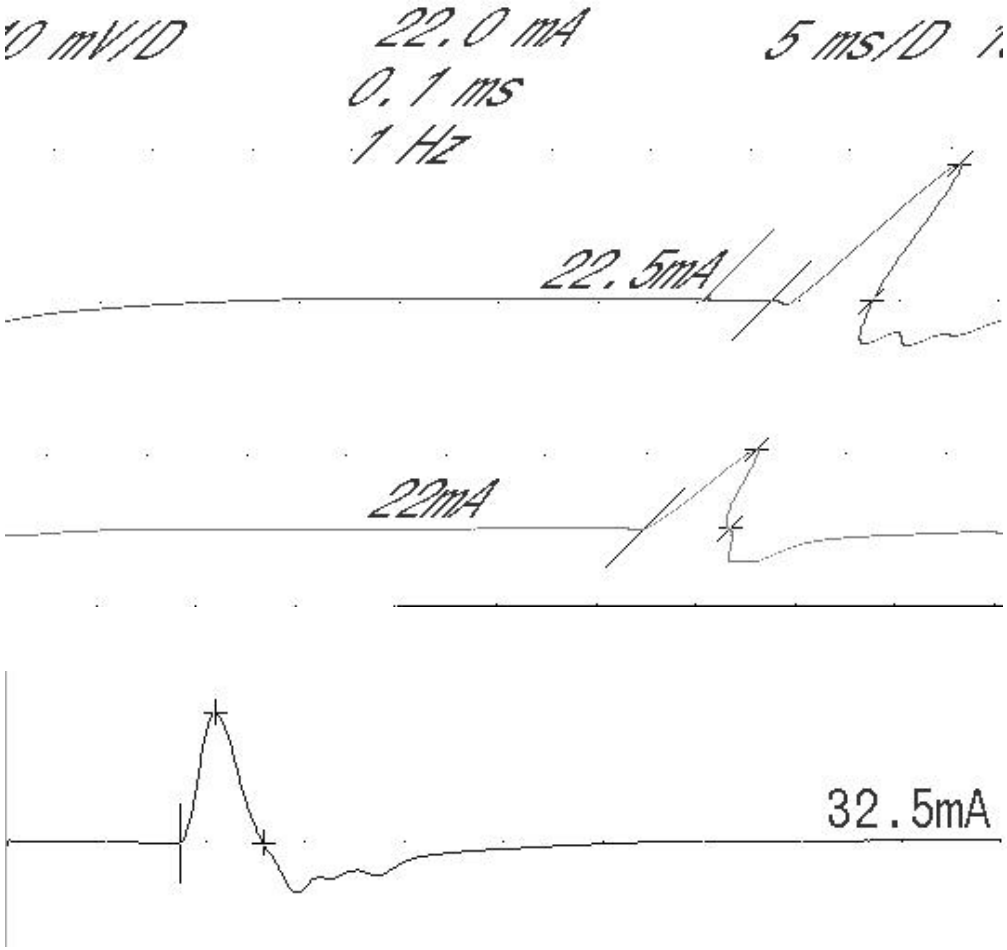


Conduction block?

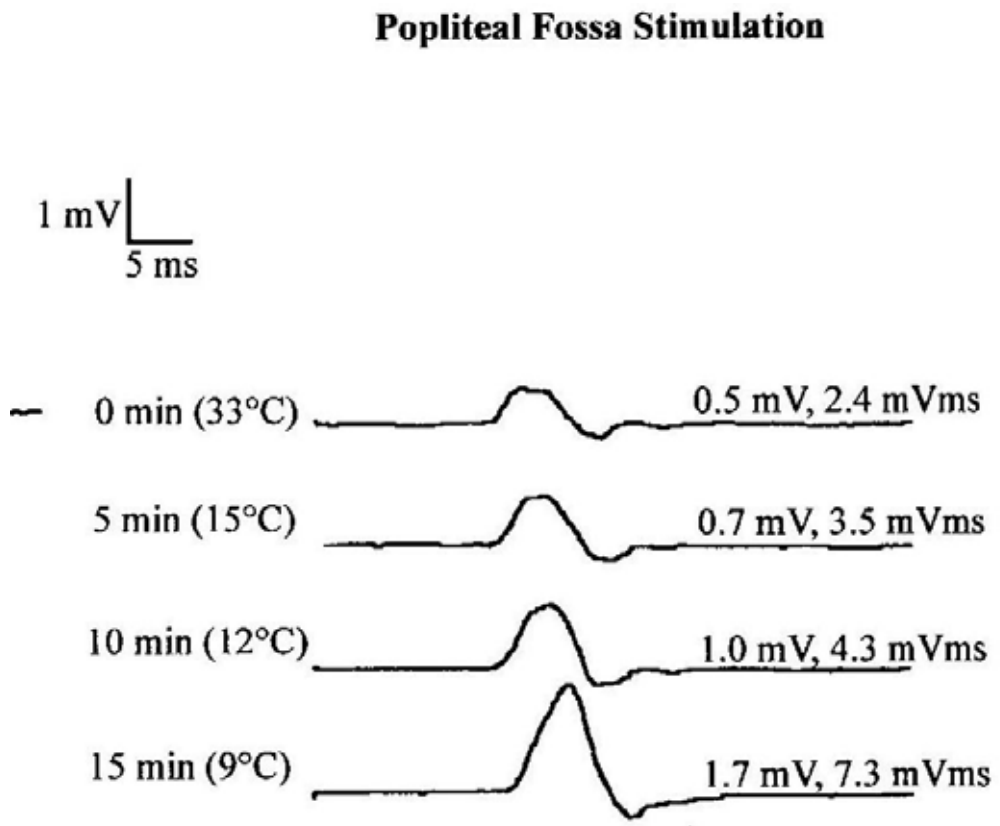



N. medianus
N. ulnaris
5 mV
5 ms

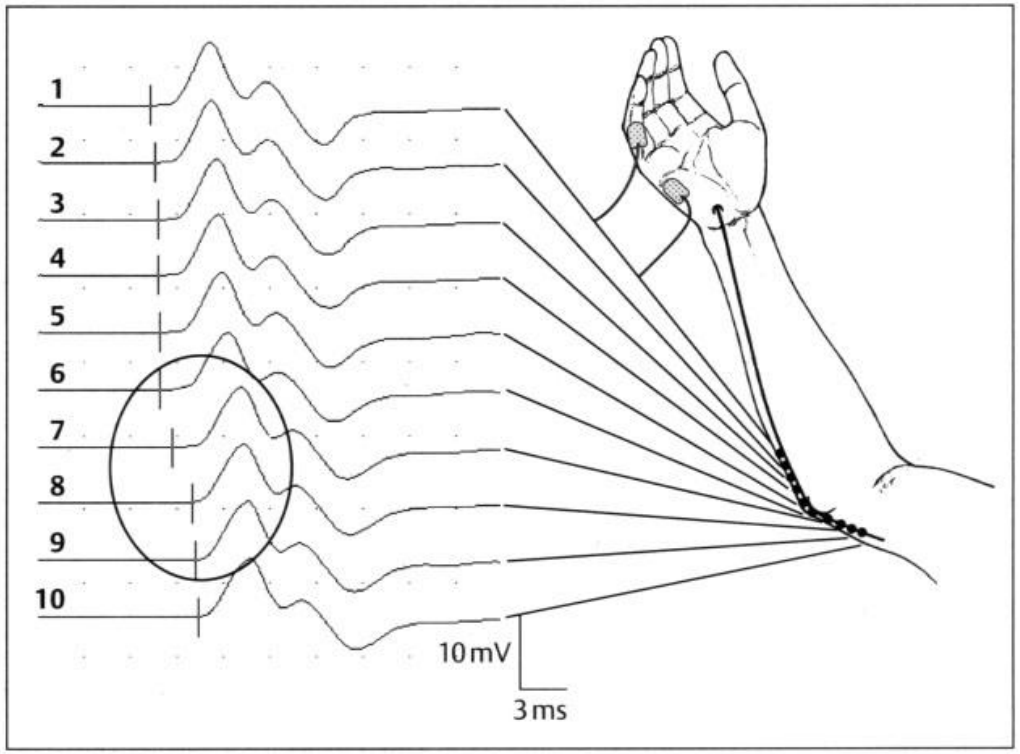
Conduction block?

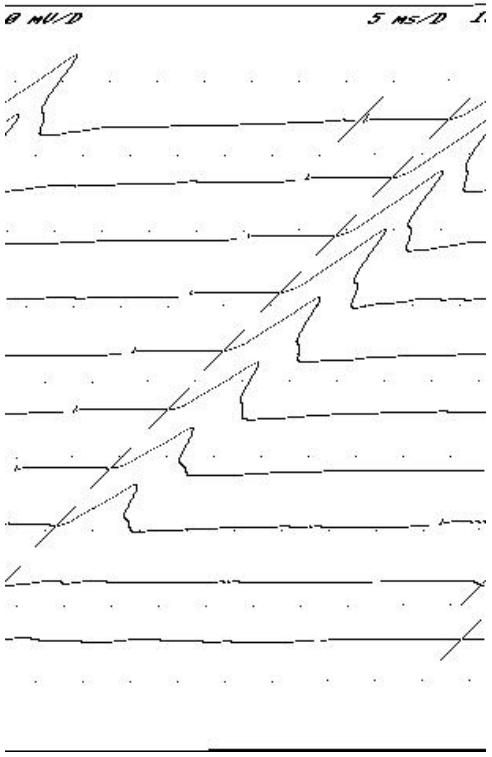


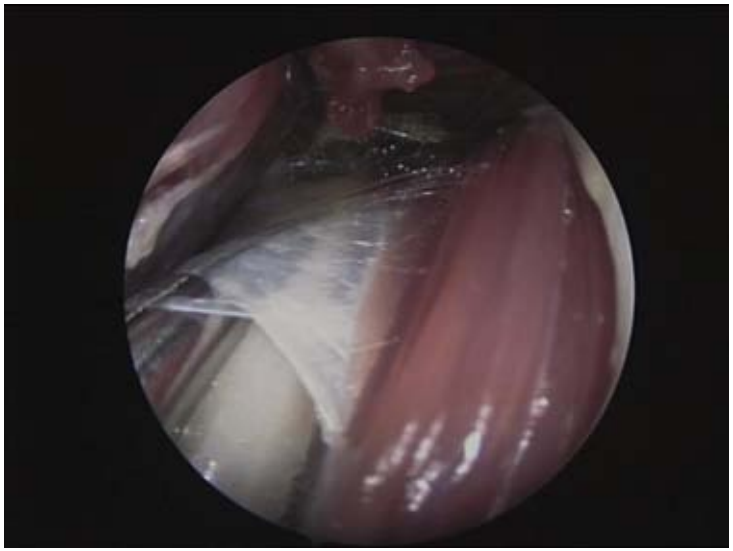
Conduction block depends on temperature

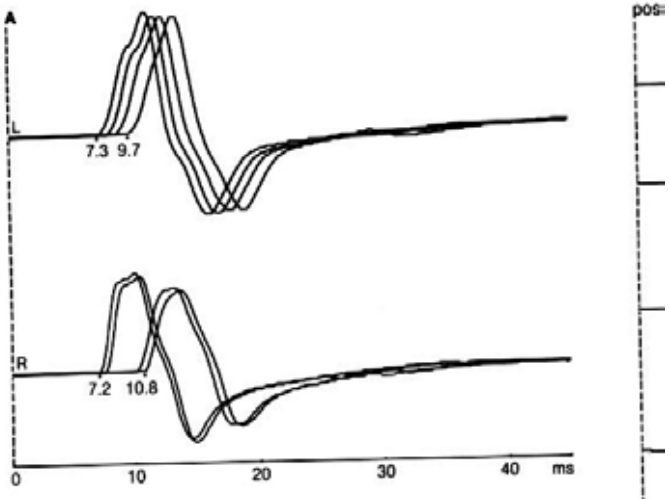


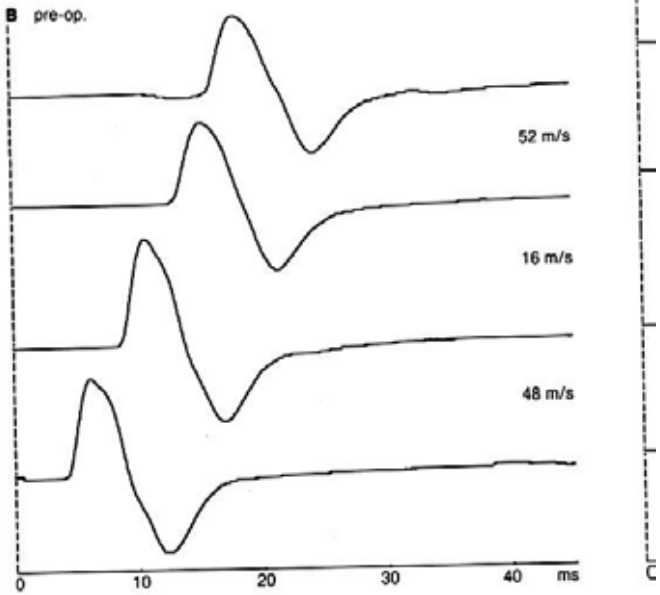
Short segment stimuation
Inching at the ellbow



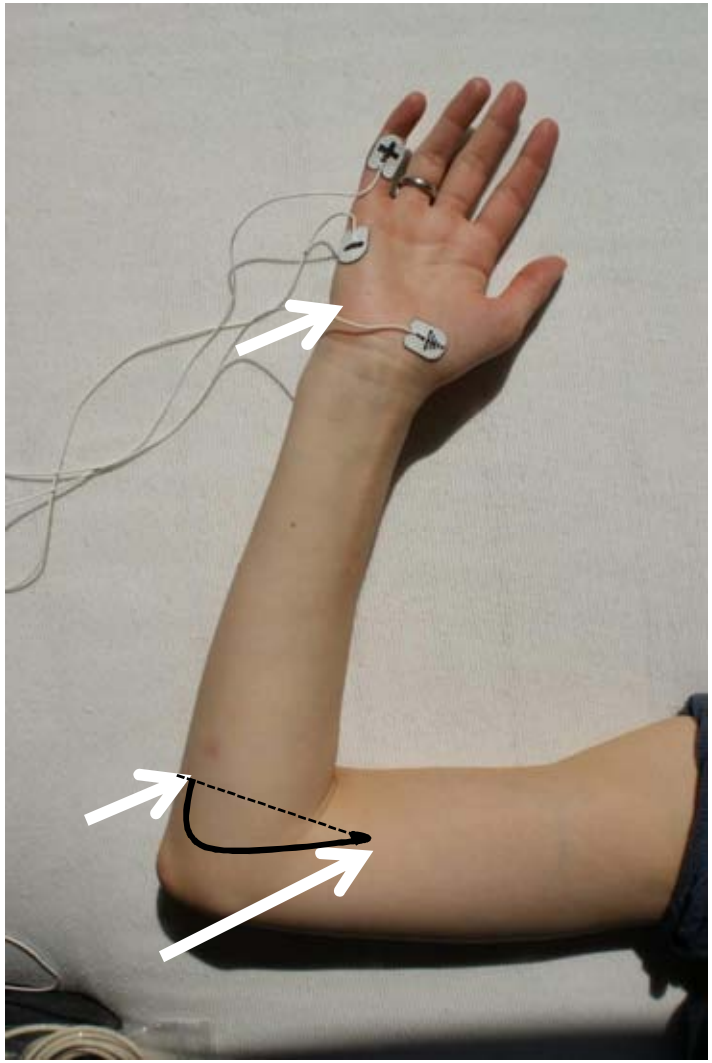


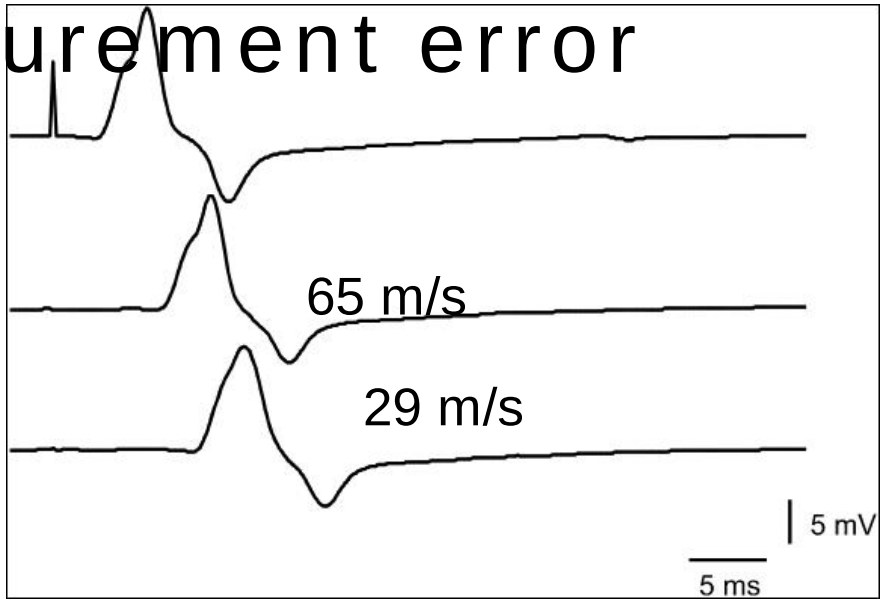


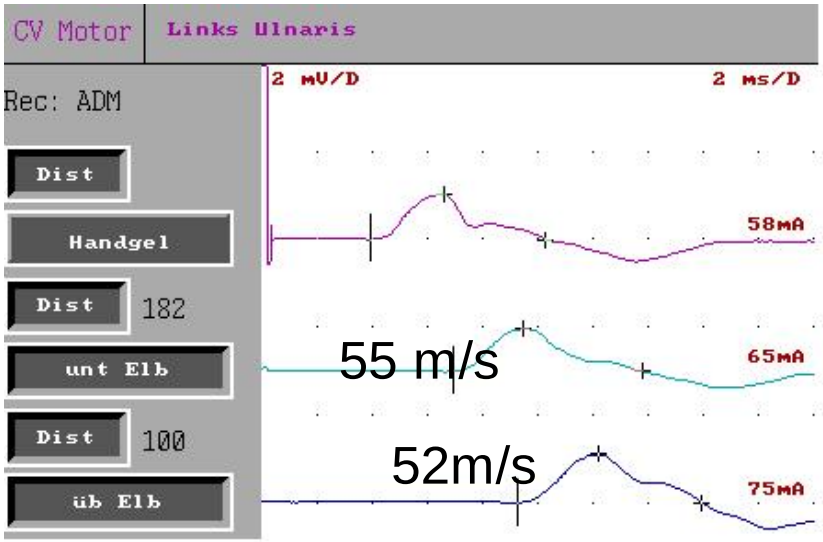

A
L
7.3 9.7
R
7.2 10.8
0
10
20
30
40
ms


B pre-op.
52 m/s
16 m/s
48 m/s
0
10
20
30
40
ms

Length measurement error







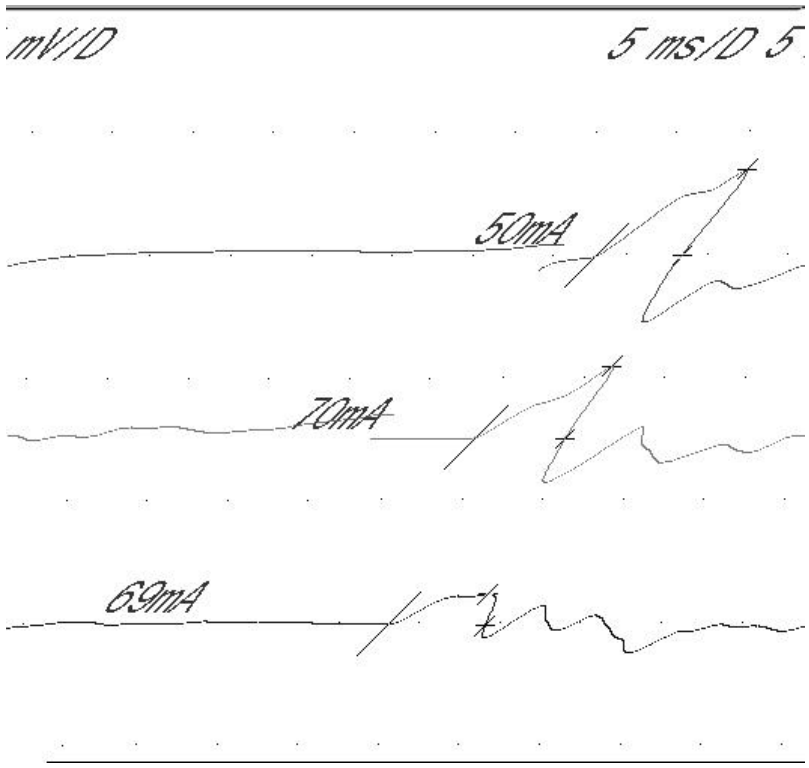
Pitfalls in sensory neurography

- Stimlus intensity too low (submaxima)
- Stimulus intensity too high
- Wrong position of the electrodes
- Temperature
- Anomaly of the innervation
- Not affected in proximal conduction block
- Electrical atrefacts

Chronic entrapments

- Due to repeated denervation and renervation of the nerve segent:
    - Segmental slowing of nerve conduction velocity
    - prolonged distal motor latency
- Temporal dispersion and therefore low amplitudes
- Worst case: very complex configuration of the CMAP but normal conduction velocity
- May be combined with axonal findings

Conduction block or not?



	Amplitude mV	CV m/s	Area mVs
	3,5		11,1
50mA	2,9	50	8,1
70mA			
69mA	1,2	32	5,1

Problems of sensory NCS

- Range of reference values is very wide
- Short segment studies are necessary to show conduction blocks
- loss of SNAP may due to
  - axonal loss
  - pronounced demyelination

Indications

- Conduction block
  - (only) technique to figure it out
  - total or partial
  - multifocal
- Chronic nerve compression
- Differentiation between plexopathy and radiculopathy
- Demyelinating neuropathies
  - pattern of affected nerves