

Ufa, 2016

What should a neurologist know about „EMG“?

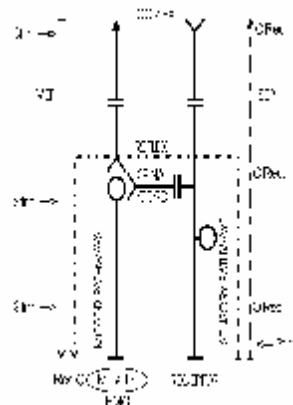
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Clinical Neurophysiological Testing

David B. Vodusek

*„EMG“ = Clinical Neurophysiological tests of
nerve and muscle “function”.*

*All these tests are
electrophysiological tests.*

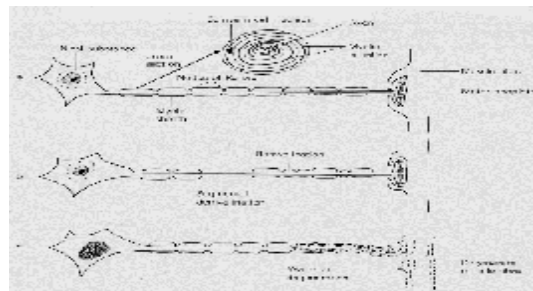


Testing "function" means:

Revealing (patho)physiological processes *

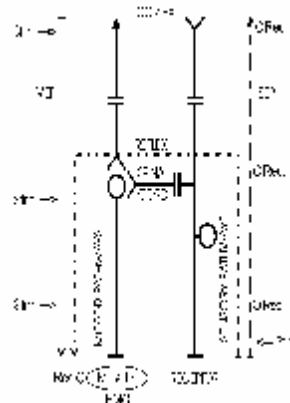
Revealing pathological processes *

* of muscles and the nervous system



Functional anatomical entities tested by clinical neurophysiological tests:

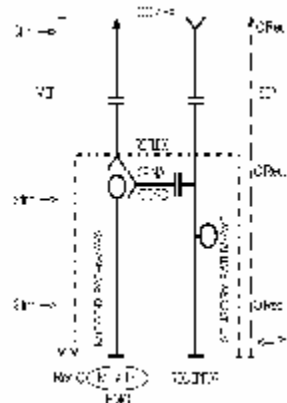
- **striated muscles**
- **neuromuscular transmission**
- **somatic motor pathways**
- **somatic sensory pathways**
- visceral sensory pathways
- sympathetic pathways
- (smooth muscle)



Electrophysiological tests can be categorised “anatomically”:

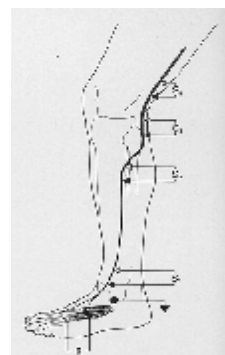
Tests for

- **striated muscles**
- **neuromuscular transmission**
- **somatic motor pathways**
- **somatic sensory pathways**
- visceral sensory pathways
- sympathetic pathways
- (smooth muscle)



Testing the peripheral nerves and muscles, for didactic reasons, two groups of tests are distinguished:

- **EMG**
- **Tests of conduction**
(of motor, sensory, and sympathetic nervous pathways).



Testing conduction through nervous pathways -

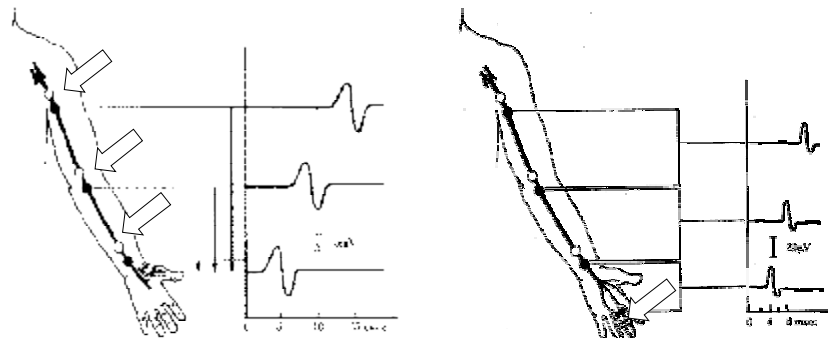
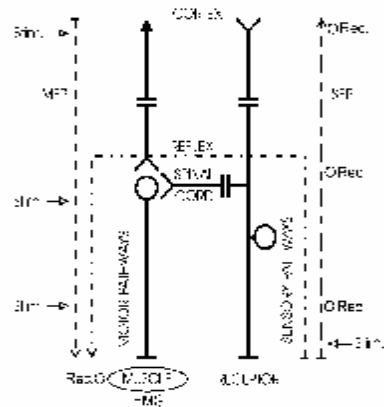
Testing conduction means applying **stimulation**, and **recording**

time-locked responses –

from muscle;

from nerves;

from other nerve structures.



Tests of conduction of nervous pathways

Responses recorded from **muscle** on **electrical** stimulation of **motor** pathways (*M wave, MEP*);

Potentials recorded from **sensory** pathways on **electrical** stimulation of sensory nerve fibers (*neurogram, SEP*),

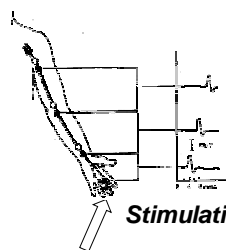
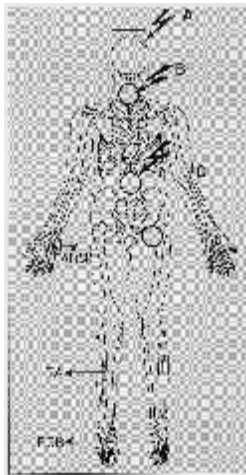


Conduction through **motor** pathways

Recording from muscle.

Stimulating

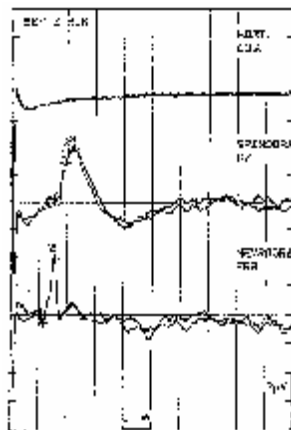
- ⇒ *peripheral nerve*
- ⇒ *motor roots*
- ⇒ *spinal cord*
- ⇒ *brain / motor cortex (magnetically)*



Conduction through **sensory** pathways

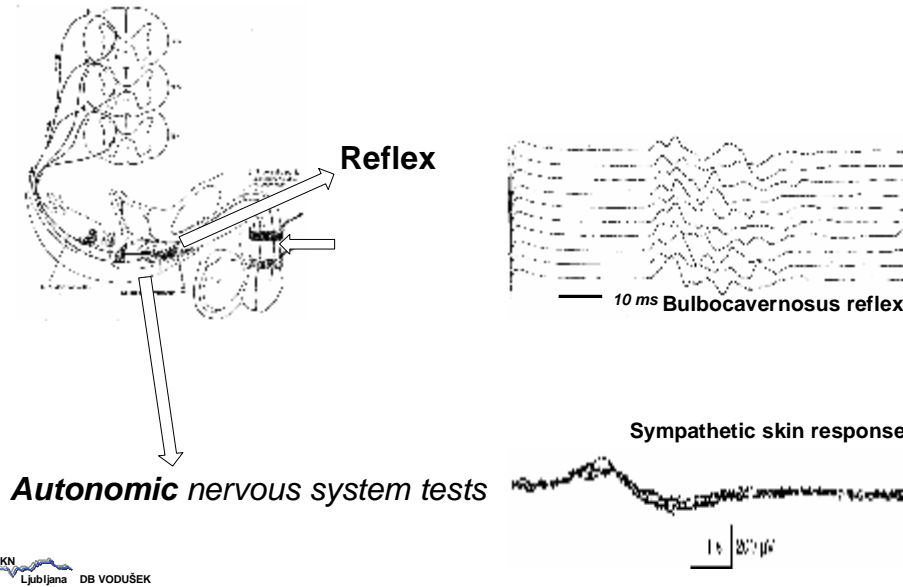
Stimulating peripheral nerve (electrically)

- Recording**
- ⇒ *from somatosensory cortex*
 - ⇒ *from spinal cord*
 - ⇒ *from peripheral nerve*



SEP on stimulation of median nerve in a case of severe brain injury

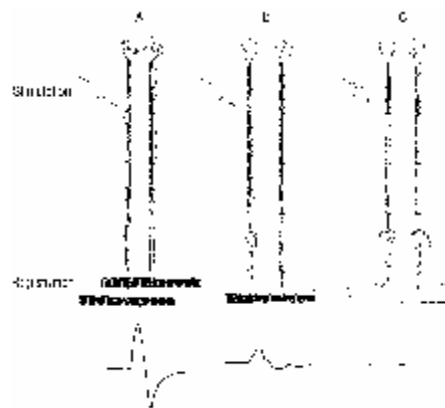
Tests of conduction of nervous pathways



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Conduction through nervous pathways is affected by -

Axonal injury/ loss



-- amplitude of response smaller

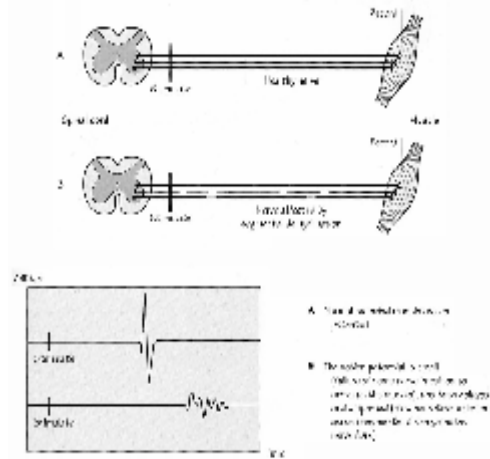
Conduction (latency) may be preserved due to preservation of some axons!

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Conduction through nervous pathways is affected by -

Demyelination

- ----- slowed conduction
- ----- block of conduction

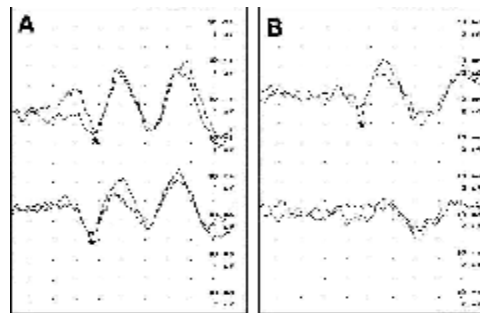


Compound muscle action potential (M wave) on stimulation in a normal nerve and in a patient with demyelination neuropathy (below: delayed latency!)

Conduction through nervous pathways is affected by -

Demyelination

- ----- slowed conduction
- ----- block of conduction



Somatosensory EP to unilateral dorsal clitoral nerve stimulation in a normal woman and a woman with MS (right panel: much delayed latency!)

(courtesy Claire C. Young)

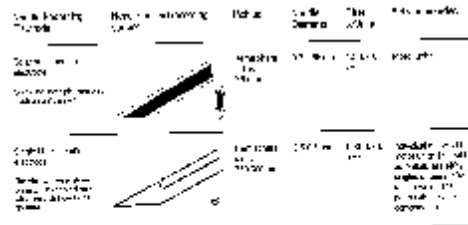
Testing EMG means recording from muscle – by different type of electrodes

Concentric needle electrode

Single fibre electrode

Wire electrodes

Surface electrodes

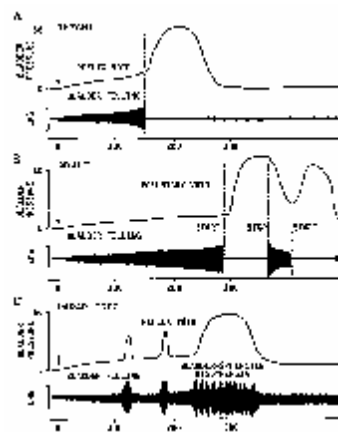
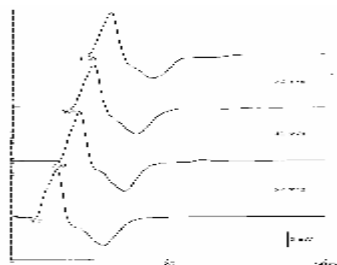


The EMG signal from an innervated muscle is -

- 1) An indicator of muscle **activity**.

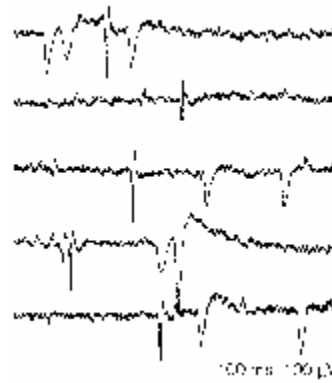
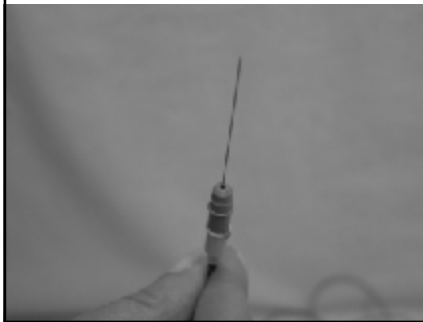
Kinesiological EMG activity from sphincter muscle on bladder filling and emptying.

M waves on stimulation of median nerve at various sites from distal to proximal.



The EMG signal can also be -

- 2) An indicator of muscle **denervation.**
("diagnostic EMG")

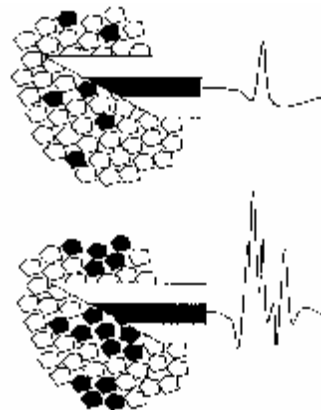


Pathological spontaneous activity in deltoid muscle (fibrillation potentials, positive sharp waves) appear 2 - 3 weeks after nerve lesion).

The EMG signal is furthermore -

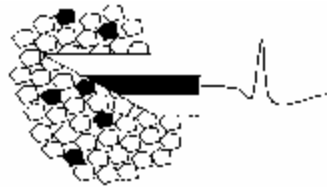
- 2) An indicator of muscle **denervation.**

- 3) An indicator of muscle **reinnervation.**
("diagnostic EMG")

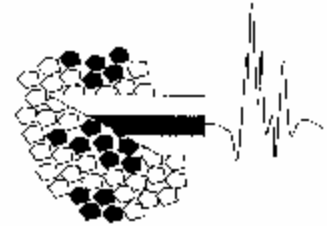
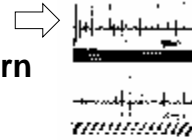


Schematically represented concentric needle EMG electrode in muscle, a motor unit and its potential (normal above; reinnervated below).

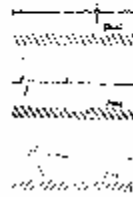
Detection of changes due to reinnervation:



By analysing the interference pattern

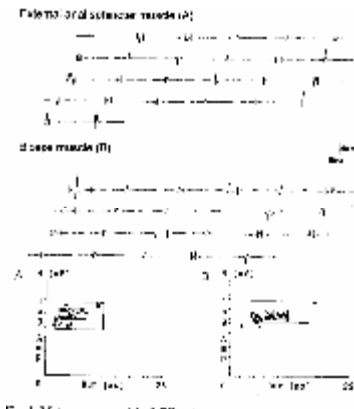


By analysing motor unit potentials (MUPs)



EMG signal analysis by concentric needle electrode is the accepted test to reveal signs of muscle reinnervation.

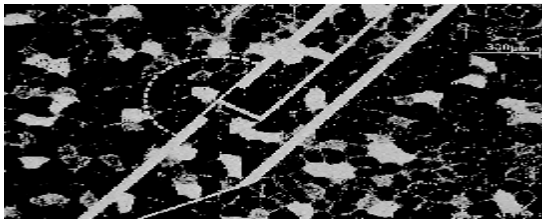
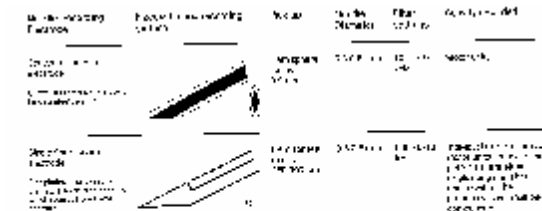
Multi-MUP analysis of the CNEMG signal



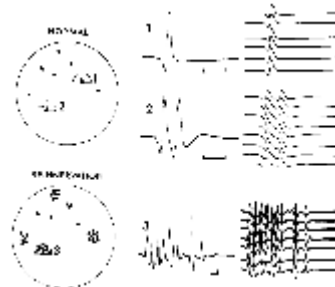
Well standardized, non-biased, fast diagnosis of muscle pathology all over the body.



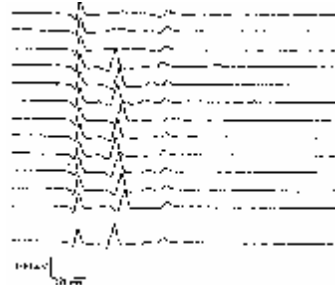
Single fiber EMG (SF EMG)



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Fibre density

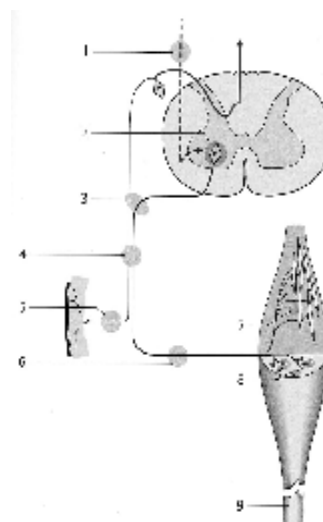


Neuromuscular jitter and blocking

Recommendation for Clinical Neurophysiological Testing

The information on the nervous system and muscles gained by clinical examination

may be enhanced and documented by neurophysiological tests in selected patient groups with **suspected neurogenic or myogenic neuromuscular system involvement.**

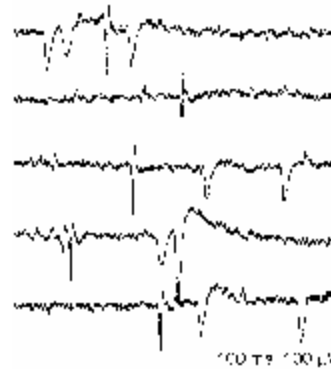


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In practice, we use clinical neurophysiological tests -

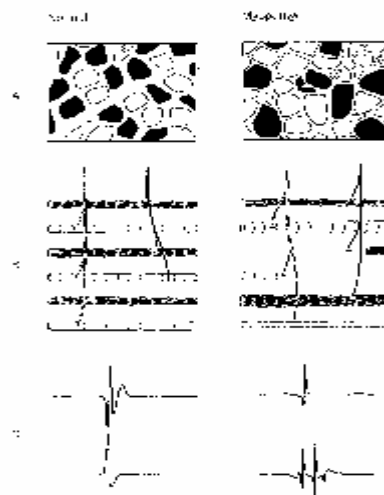
- A. To make a diagnosis of a **lesion of the nervous system** & denervation / reinnervation of muscle

- For instance: To demonstrate *deltoid muscle denervation after a traumatic shoulder dislocation*



In practice, we use clinical neurophysiological tests -

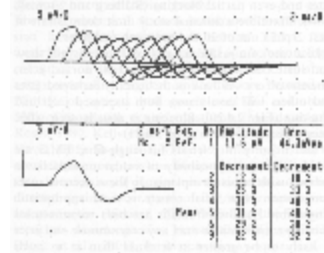
- B. To support a diagnosis of **myopathy**.



Small polyphasic motor unit potentials, not reduced in number

In practice, we use clinical neurophysiological tests -

C. To support a diagnosis of neurotransmission dysfunction.

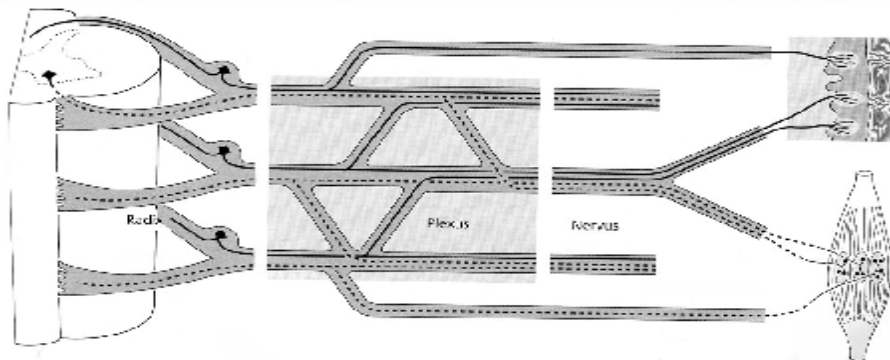


Repetitive stimulation of motor nerve; recording the **decrement** of M wave from muscle with surface electrodes in a patient with myasthenia gravis.

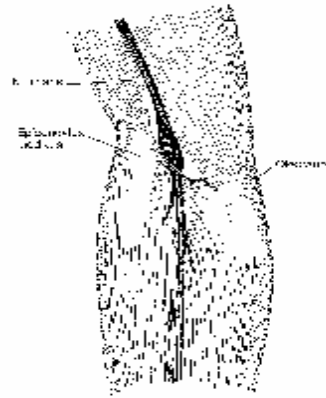
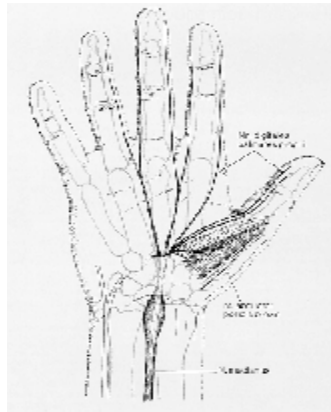
Recording neuromuscular jitter and blocking with the SF EMG needle electrode in a patient with myasthenia gravis.



Primarily, the knowledge has to be clinical.
The most important diagnostic tool is **history** and clinical examination.



Diagnosis of entrapment neuropathy



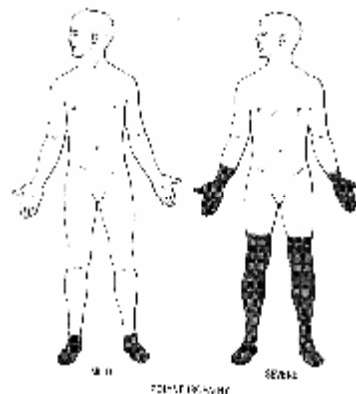
Carpal tunnel syndrome ***Cubital syndrome***

- also atypical or complex symptoms;
- diagnosis important before clinical deficits arise

Diagnosis of polyneuropathy

Nerve conduction studies –

axonal and demyelinating polyneuropathies have a different set of etiologies!



Diagnosis of compressive neuropathy

Acute compressive radial mononeuropathy

Acute compressive ulnar mononeuropathy

Acute compressive radiculopathy



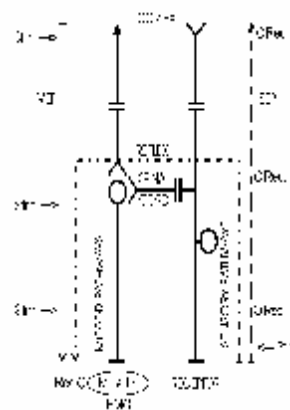
Caveats: clinical neurophysiological tests of conduction: restrictions of anatomy!

Responses recorded from muscle on stimulation of motor pathways;

Potentials recorded from sensory pathways on stimulation of sensory nerves,

Reflexes,

Autonomic nervous system tests



Caveats: clinical neurophysiological tests of conduction – restrictions of physiology!

Tests of conduction test only large myelinated nerve fibers.

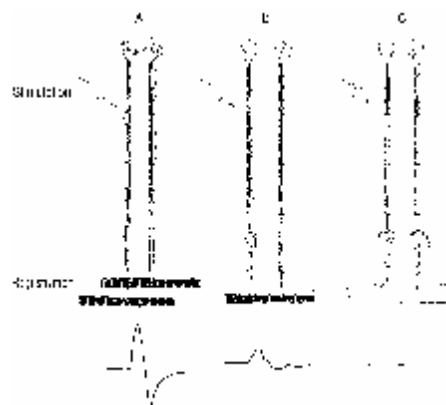


Conduction Velocity and Function of Different Nerve Fiber Types

Fiber Diameter µm	Type	Myelinated	Conduction Velocity m/sec	Function
10-15	A	YES	90	Primary spindle afferents, somatic efferents
5-12	A	YES	50	Touch and pressure afferents
4-8	A	YES	30	γ afferents, secondary spindle afferents
2-6	B	YES	10	Autonomic preganglionic
0.2-1	C	NO	2	Nociception afferents, postganglionic autonomic

Caveats: clinical neurophysiological tests of conduction – restrictions of pathophysiology!

Tests of conduction are poorly sensitive to axonal lesions, which are clinically most relevant...



CONCLUSION

Clinical neurophysiological testing complements the information gained by history and clinical examination.

The objective of testing is to

- generate (additional) knowledge about the nervous system and (striated) muscles in a given patient,
- and/or to document that information.

