Clinical Applications of Transcranial Magnetic Stimulation

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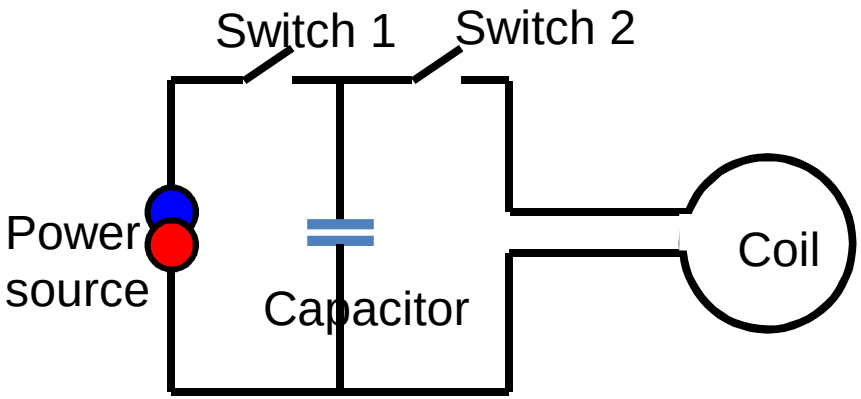
Disclosures

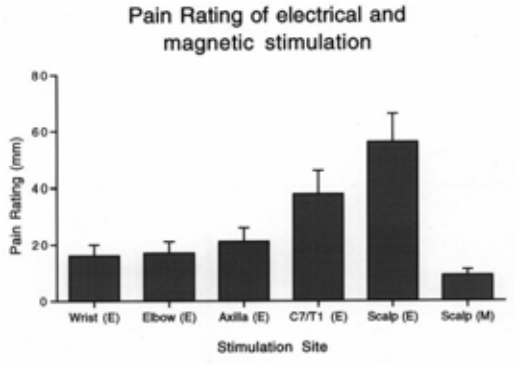
None

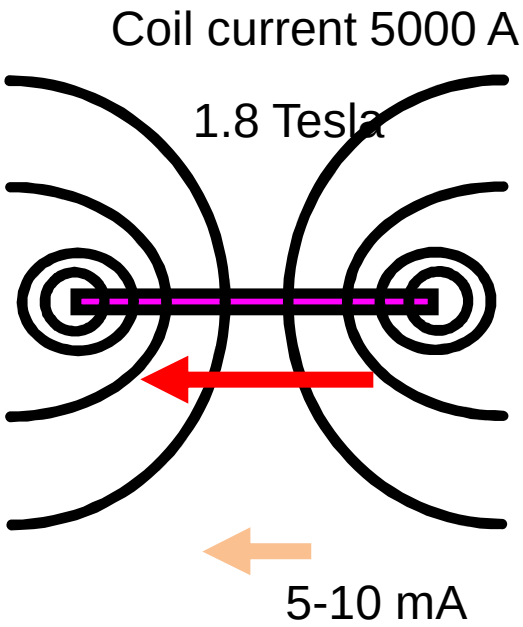
Learning Objectives

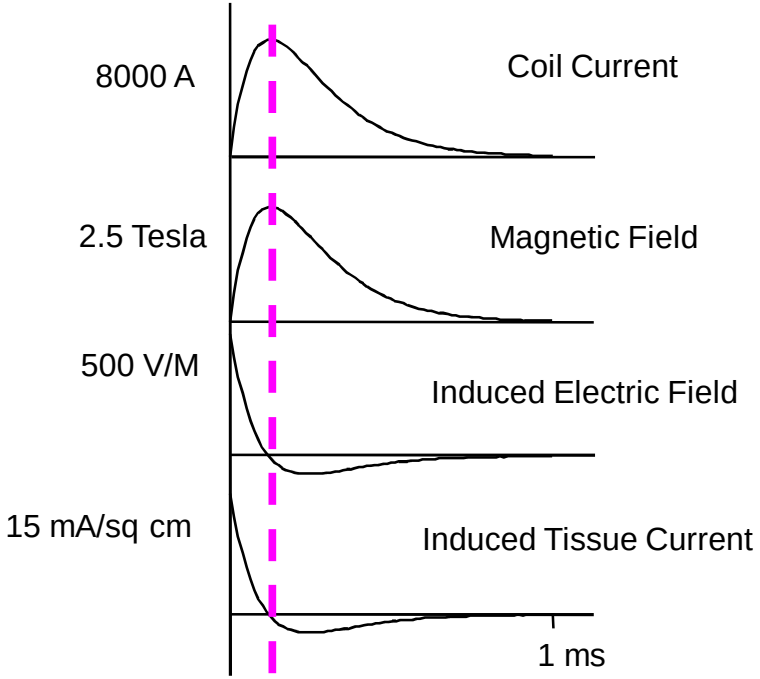
- To understand:
  - the basic principles of TMS
  - Clinical scenarios where TMS may be useful including ALS, MS, myelopathy, stroke and functional disorders

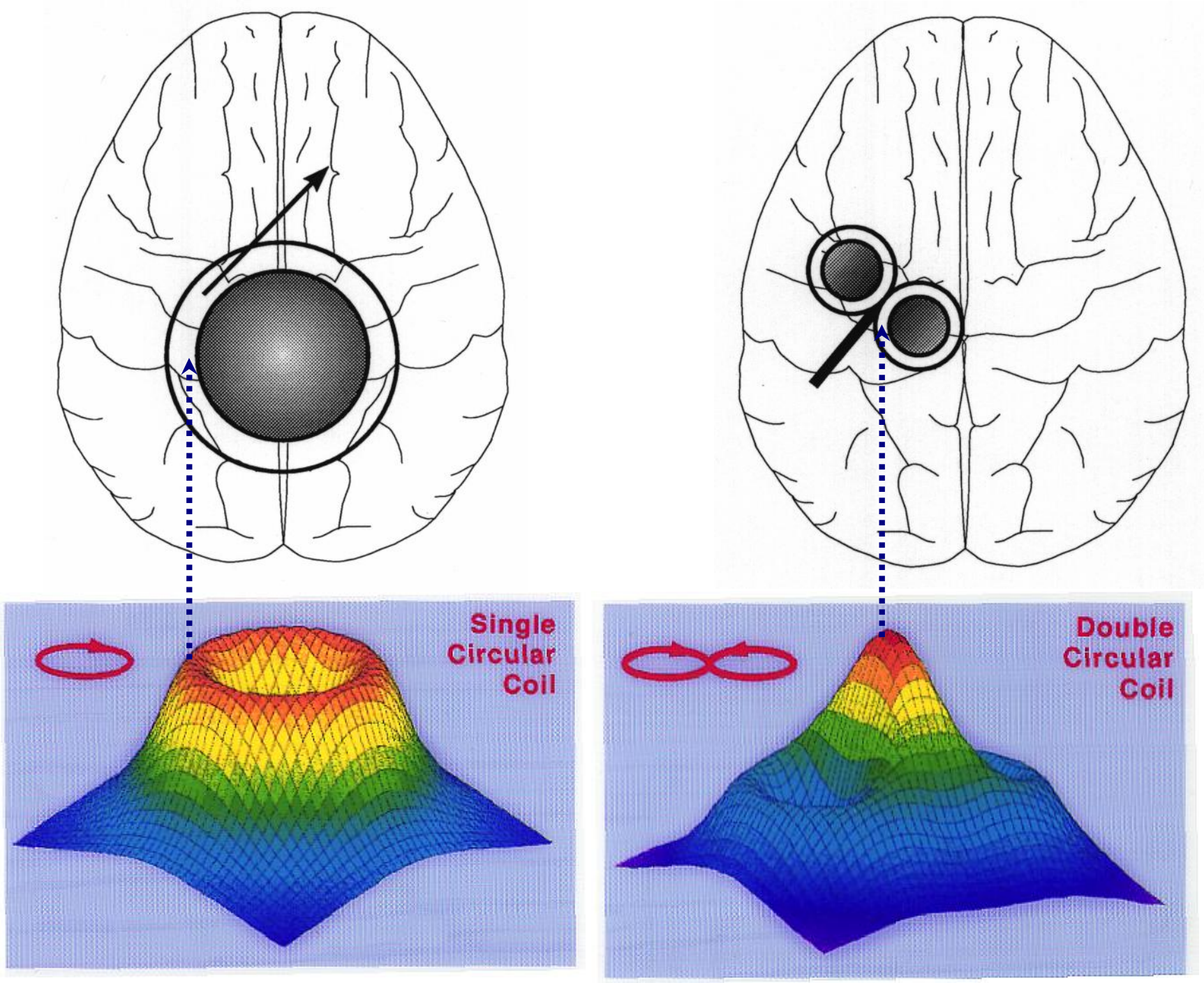
Magnetic stimulation



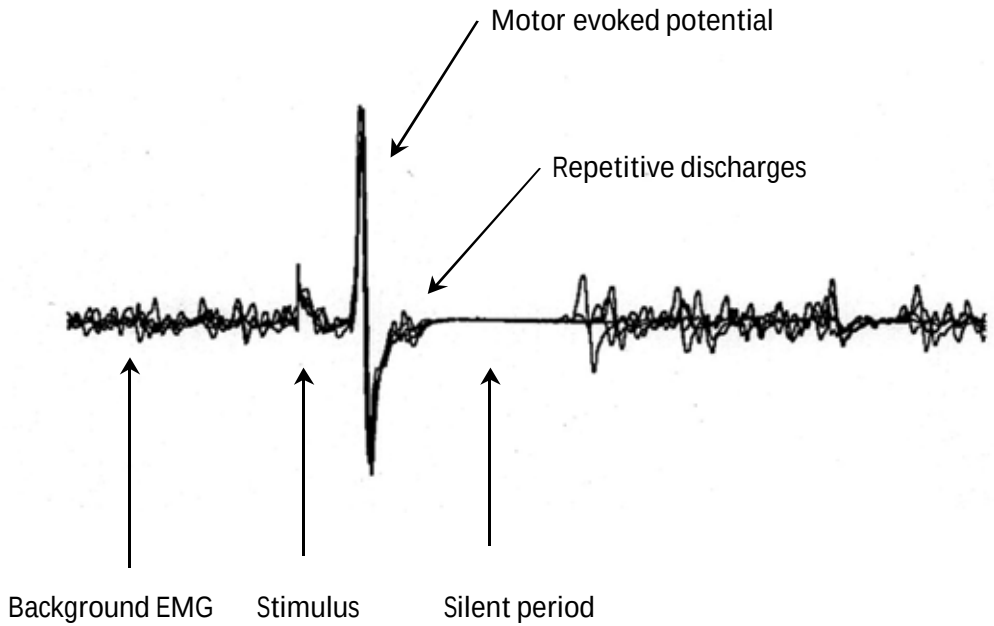






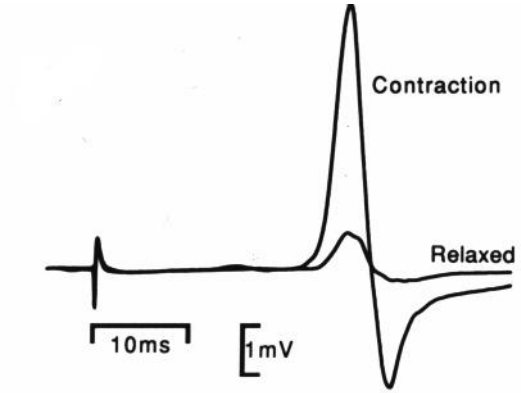

Single
Circular
Coil
Double
Circular
Coil

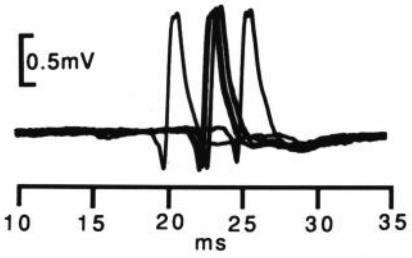
Characteristics of response to TMS



Characteristics of MEPs

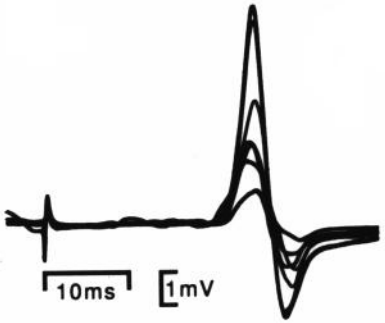
Facilitation

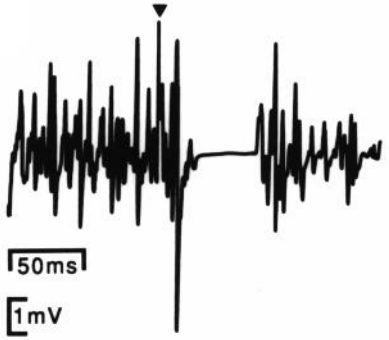




Complexity

Variability





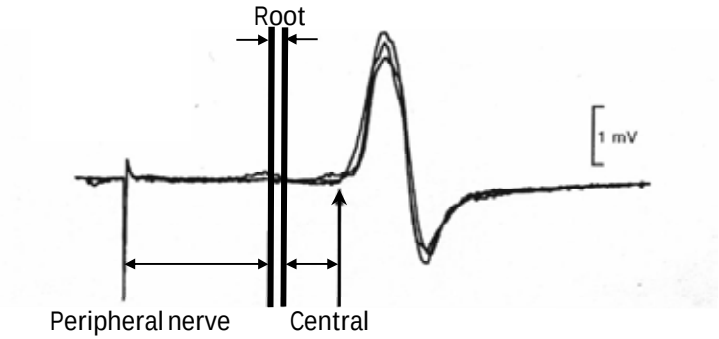
Inhibition

TMS Parameters

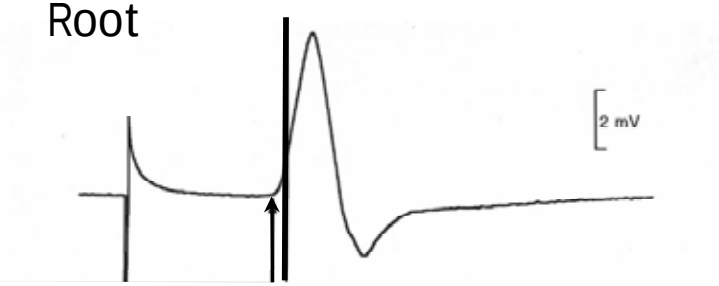
- Corticomotor threshold
- Central Motor Conduction Time (CMCT)
- Silent Period Duration
- Intracortical Inhibition

Central Motor Conduction Time

Cortex

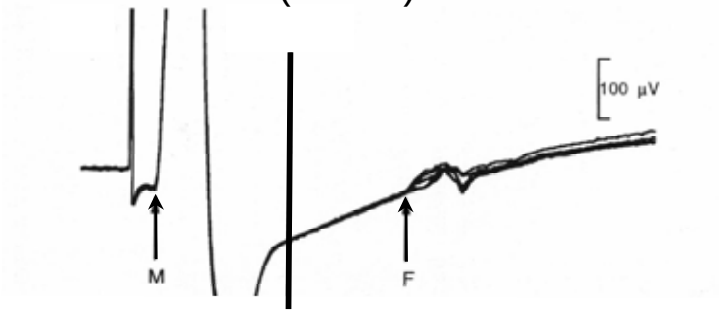


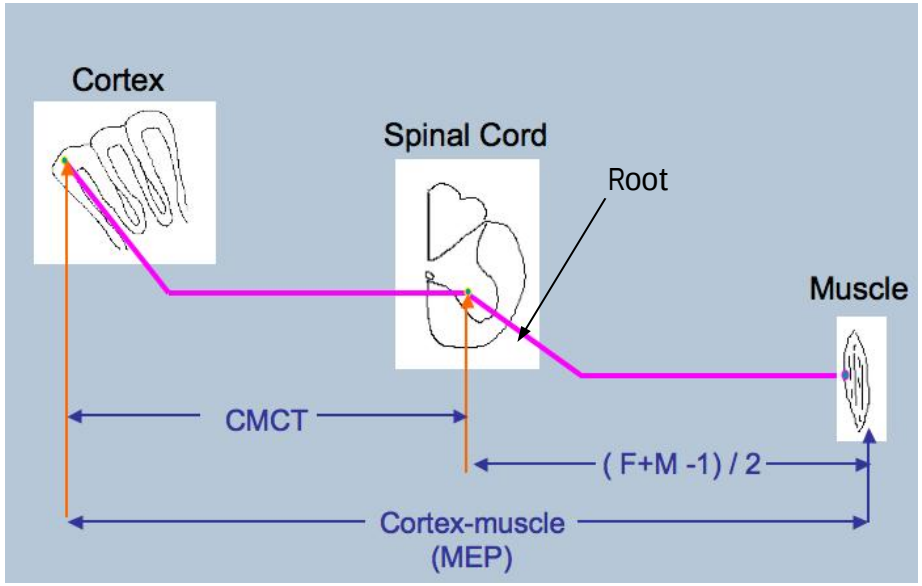
Root



Wrist

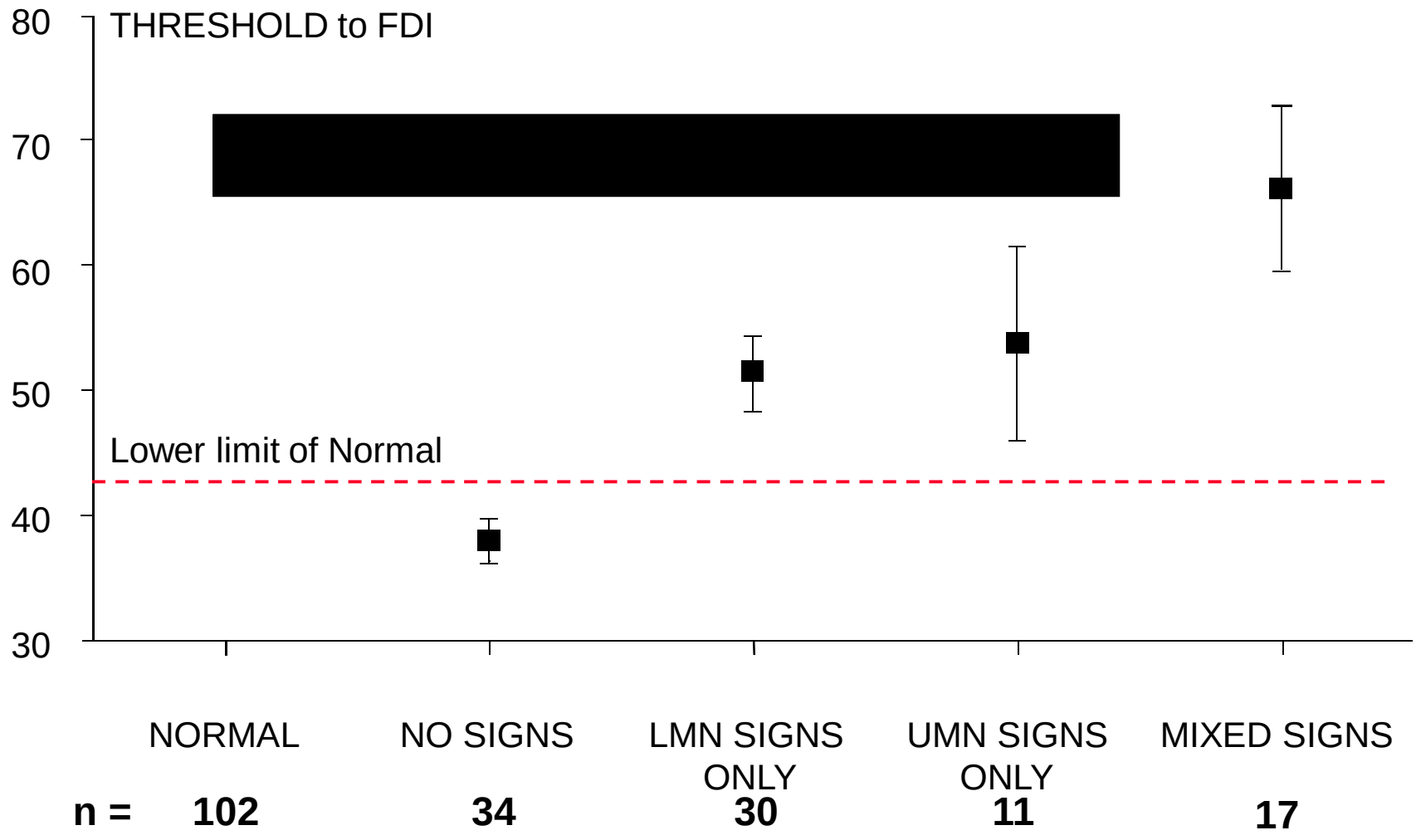
(F+M-1)/2





Muscle	CMCT
Abductor Pollicis Brevis	6.3 ± 0.4
Abductor digiti minimi	5.8 ± 0.8
First dorsal interosseous	6.5 ± 0.9
Extensor digitorm Communis	6.4 ± 1.2
Biceps	6.1 ± 1.3
Deltoid	6.5 ± 0.5
Tibialis Anterior	14.8 ± 1.1
Quadriceps	13.0 ± 1.4
Abductor Hallucis	13.8 ± 0.9

Corticomotor Threshold in ALS



CMCT in ALS

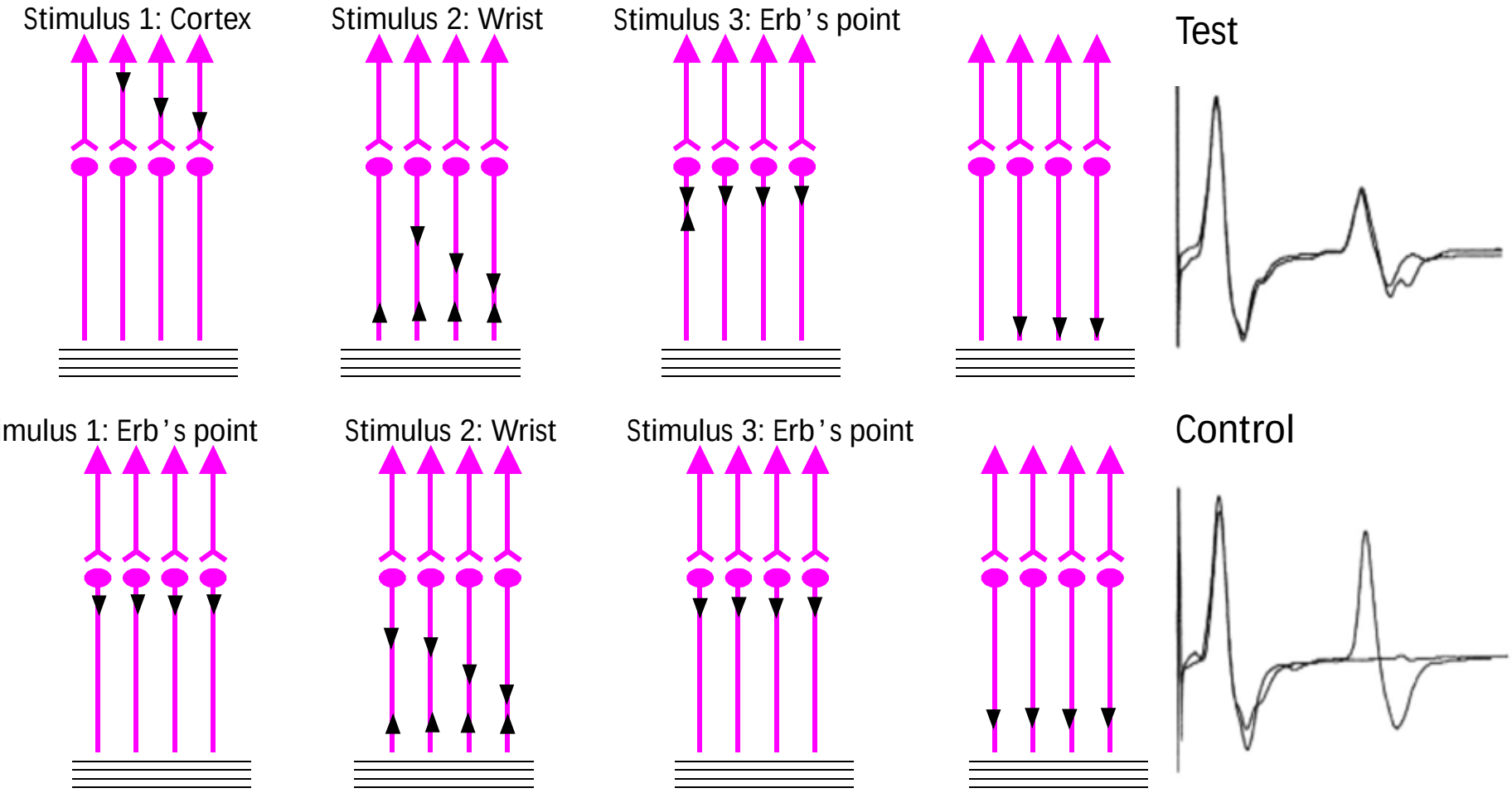
- ALS: prolonged in about 20% of cases; hit rate improves as more muscles examined.
- ALS: prolongation 3-5 ms only; not correlated with signs.
- ALS: No change with disease evolution
- FALS: Normal or markedly prolonged (D90A)
- PLS: Prolonged if measurable
- SMA: Normal

Clinical Scenarios where TMS may be useful in Possible ALS

- No UMN signs
- Differential with myelopathy
- Differential with MMN

- Abnormal CMC gives evidence of UMN lesion
- Slowing usually greater than with ALS
- No CB in ALS; normal CMCT in MMN

Triple stimulation technique



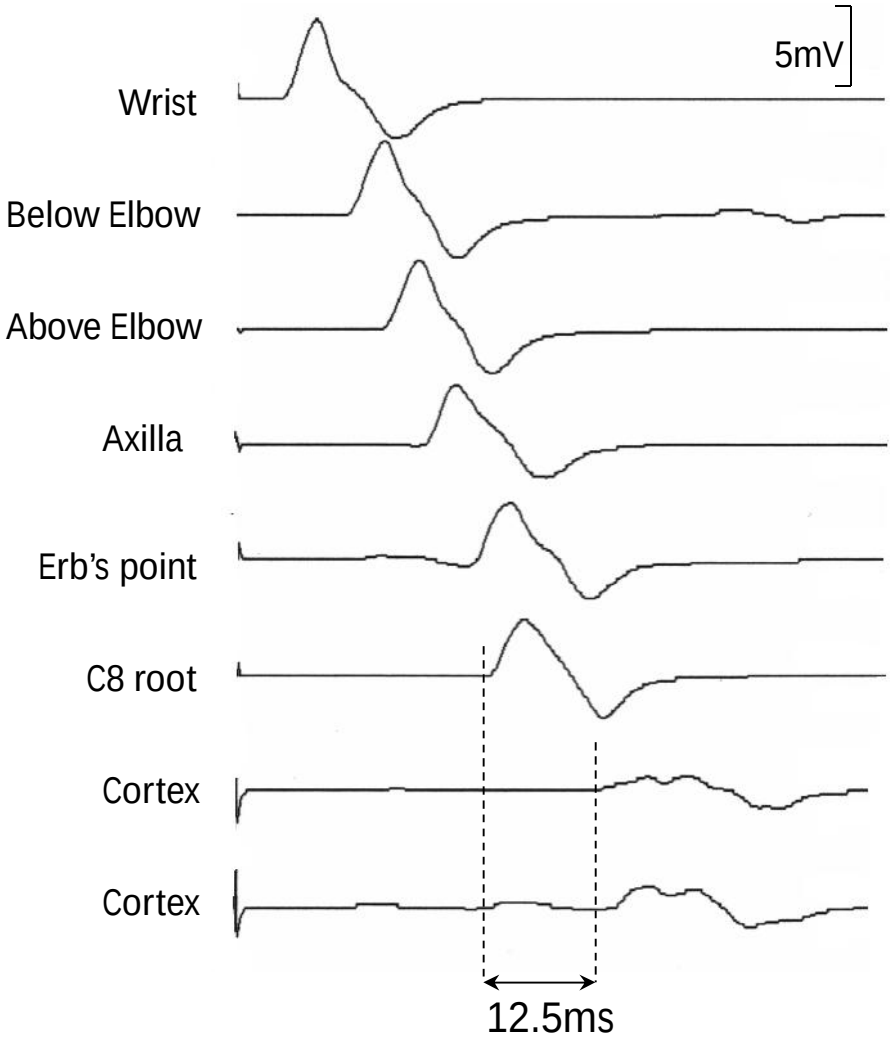
TST Summary

- TST quantifies UMN loss
- TST more sensitive than CMCT
- TST can detect subclinical UMN loss
- In UMN syndrome, TST response size correlates with muscle weakness

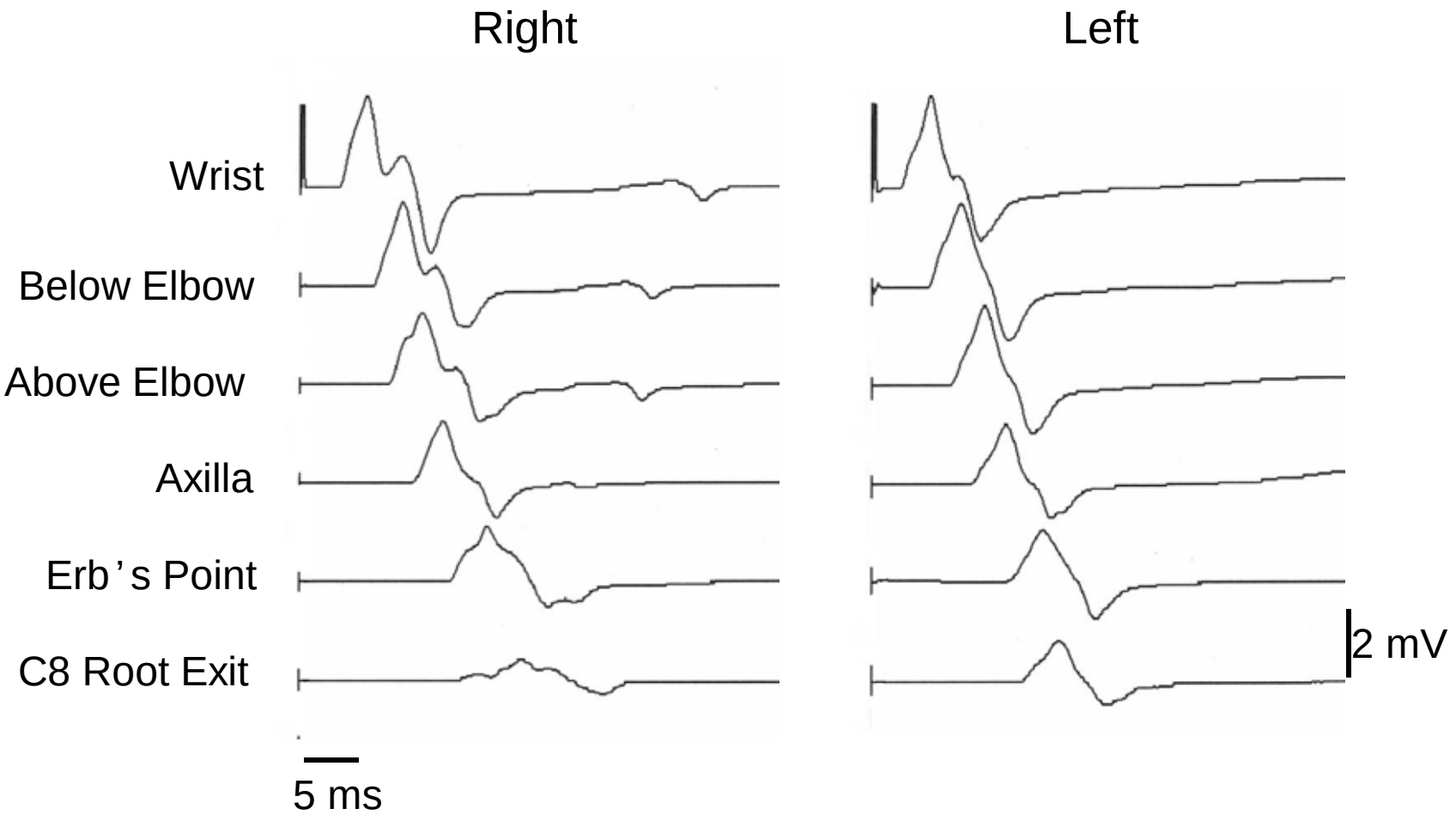
ALS vs MMN

35 yr old man with 6 month history of weakness of right sided ulnar hand muscles. No sensory loss. Fasciculations in upper limb muscles. Reflexes in legs brisk.

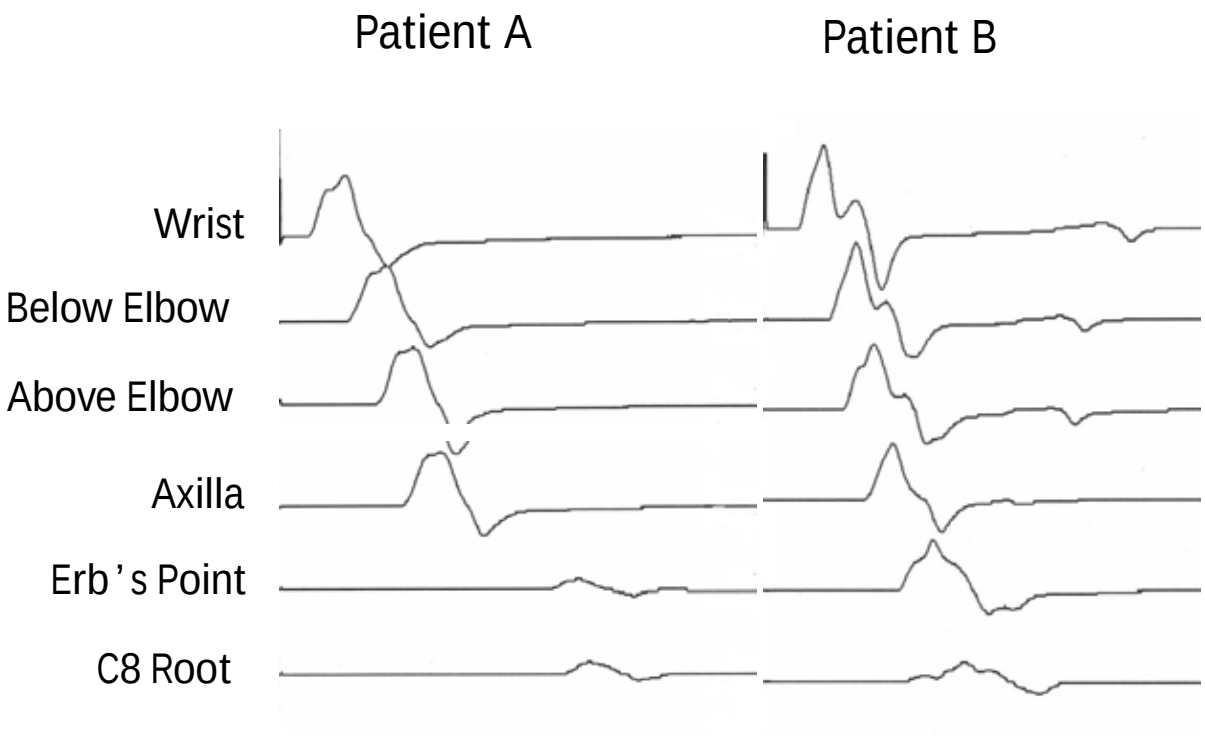
? ALS
?MMN

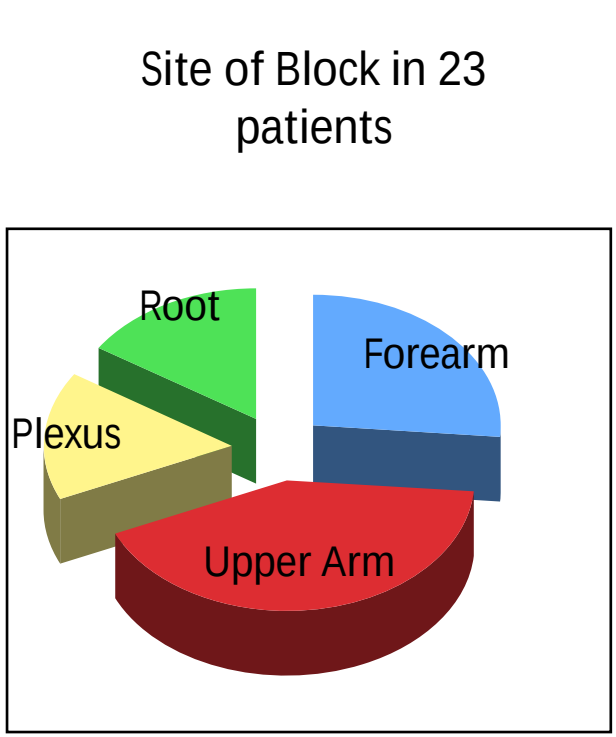


MMN: Motor Study



Conduction Block in MMN



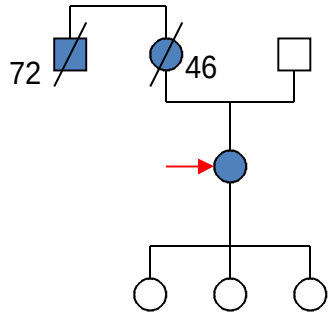


Familial ALS: D90A mutation

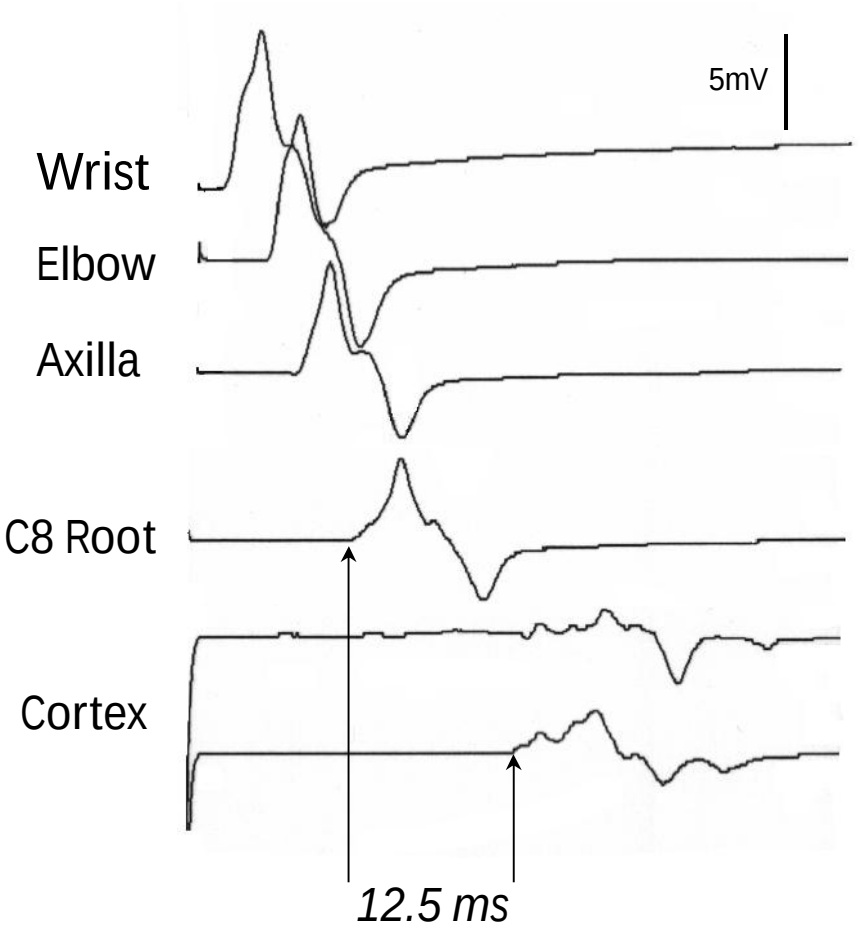
46 yr old lady
2 year history of progressive weakness of arms, beginning proximally. Twitching of R arm.

Weak neck flexion. Weakness of both arms R>L, Proximal>distal. Arm reflexes absent. No sensory abnormality.
Hip flexion slightly weak. Reflexes normal. Plantars flexor

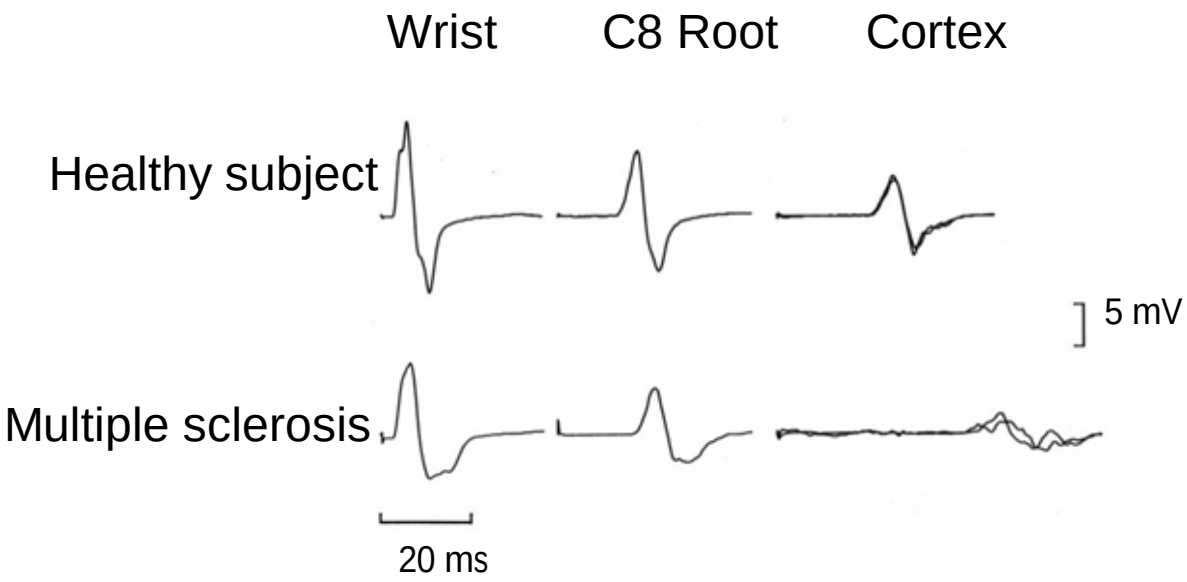
Family History



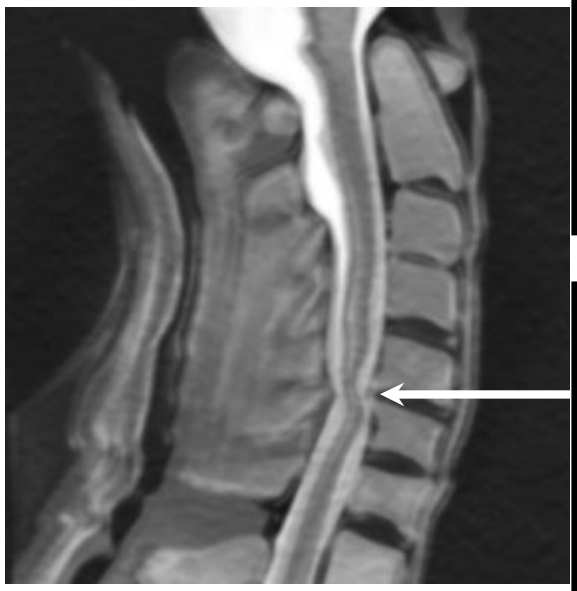
R Ulnar Motor Study
Recording ADM



Multiple Sclerosis



Myelopathy



Cord Compression

- CMCT prolonged on average 1.6 times normal
- 90% of patients with radiological compression have abnormal CMC
- CMC can detect subclinical compression

Stroke

- CMCT prolonged on average 1.2 times normal
- Response correlates with site of lesion especially in internal capsule
- Response to TMS predicts outcome
- Subset of patients with very prolonged silent period have motor neglect

Neurodegenerative conditions

Condition	E/M	Threshold	N	Central Motor Conduction Time (ms) *		% Patients with abnormal CMC	
				Upper Limb	Lower Limb	Upper Limb	Lower Limb
Friedreich's Ataxia	M		11	12.7 (6.2)		91	
	M	High	20	13.7 (4.6)	41.9 (28.4)	100	100
	E	High	15	8.5 (4.4)		100	
	M		4	12.3 (5.5)	22.2 (13.4)	100	100
Friedreich's ataxia	M		10	10.8 (6.2)			
with retained reflexes	E		10	7.0 (4.4)			
	M		7	7.9 (5.5)	18.3 (13.4)	43	71
ADCA (Unclassified)	M			7.8 (6.2)			
	M			13.9 (7.5)	23.0 (11.9)	50	50
	E			4.5 (4.4)			
	M			7.3 (5.5)	16.5 (13.4)	33	50
	M					15	67
SCA I	M	High				100	100
SCA II	M	Normal				10	18
EA I	M	Normal		5.8 (5.5)		0	
EA II	M	?High		5.6 (5.5)		0	

Movement disorders

Parameter	Parkinson's Disease	Huntington's Disease	Focal Dystonia
Threshold	Normal	Raised	Normal
CMCT	Normal	Normal	Normal
MEP Resting	Low		High
MEP Facilitated	High		Low
Silent Period Duration	Short	Long	Normal
Intracortical inhibition	Reduced		Reduced

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