H REFLEX

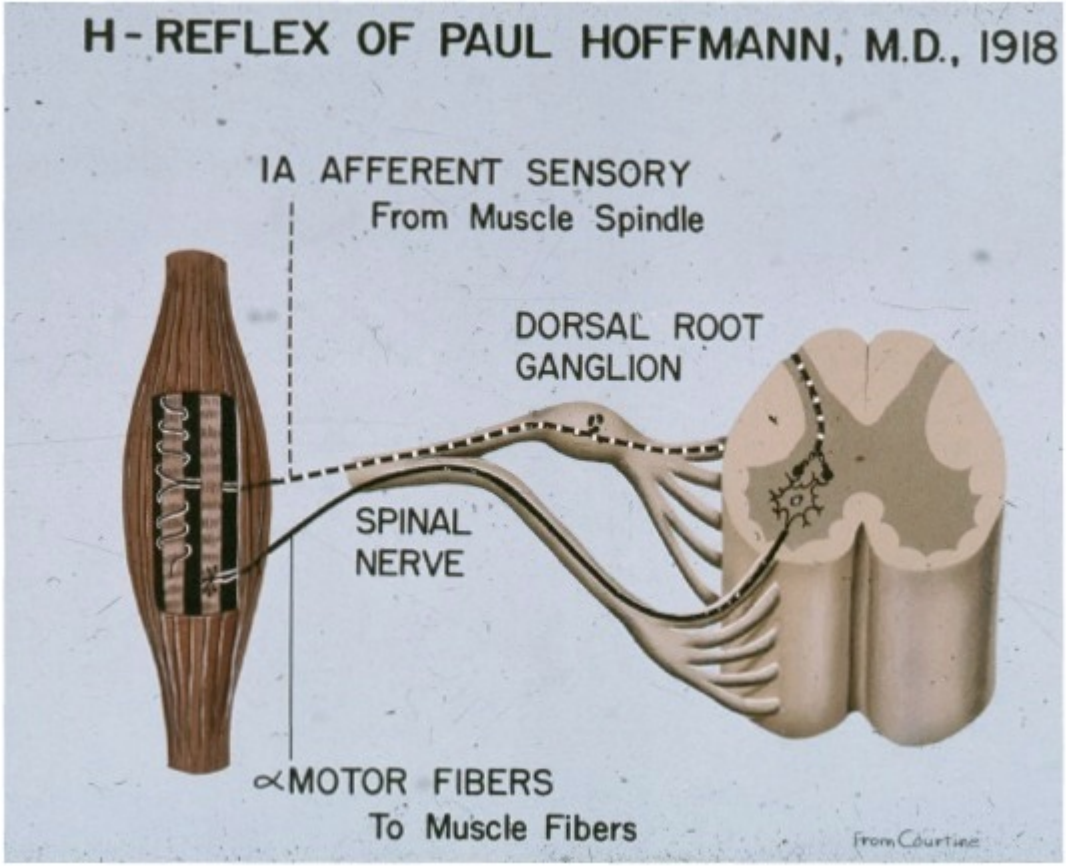
Ernest W Johnson MD, Emeritus Professor, PM&R, The Ohio State University

objectives

- To know how to elicit the H Reflex
- To use the H reflex in L/S Radiculopathy
- To use H reflex in cervical radiculopathy
- To use H reflex in other diseases

S-1 Radiculopathy

- Walking on toes is only a gross test
  - Must do heel raises unilaterally and compare (10)
  - MSR - Ankle jerk
  - Numbness lateral foot and sole
  - ***H reflex can be helpful***


H-REFLEX OF PAUL HOFFMANN, M.D., 1918
IA AFFERENT SENSORY
From Muscle Spindle
DORSAL ROOT
GANGLION
SPINAL
NERVE
∝MOTOR FIBERS
To Muscle Fibers
From Courtine

History of H reflex

- Magladery, Mc Dougal, and others have studied recovery curve of H reflex after conditioning shock in ’50’s
- Hohmann & Goodgold showed H reflex in upper limb in stroke patients. 1961

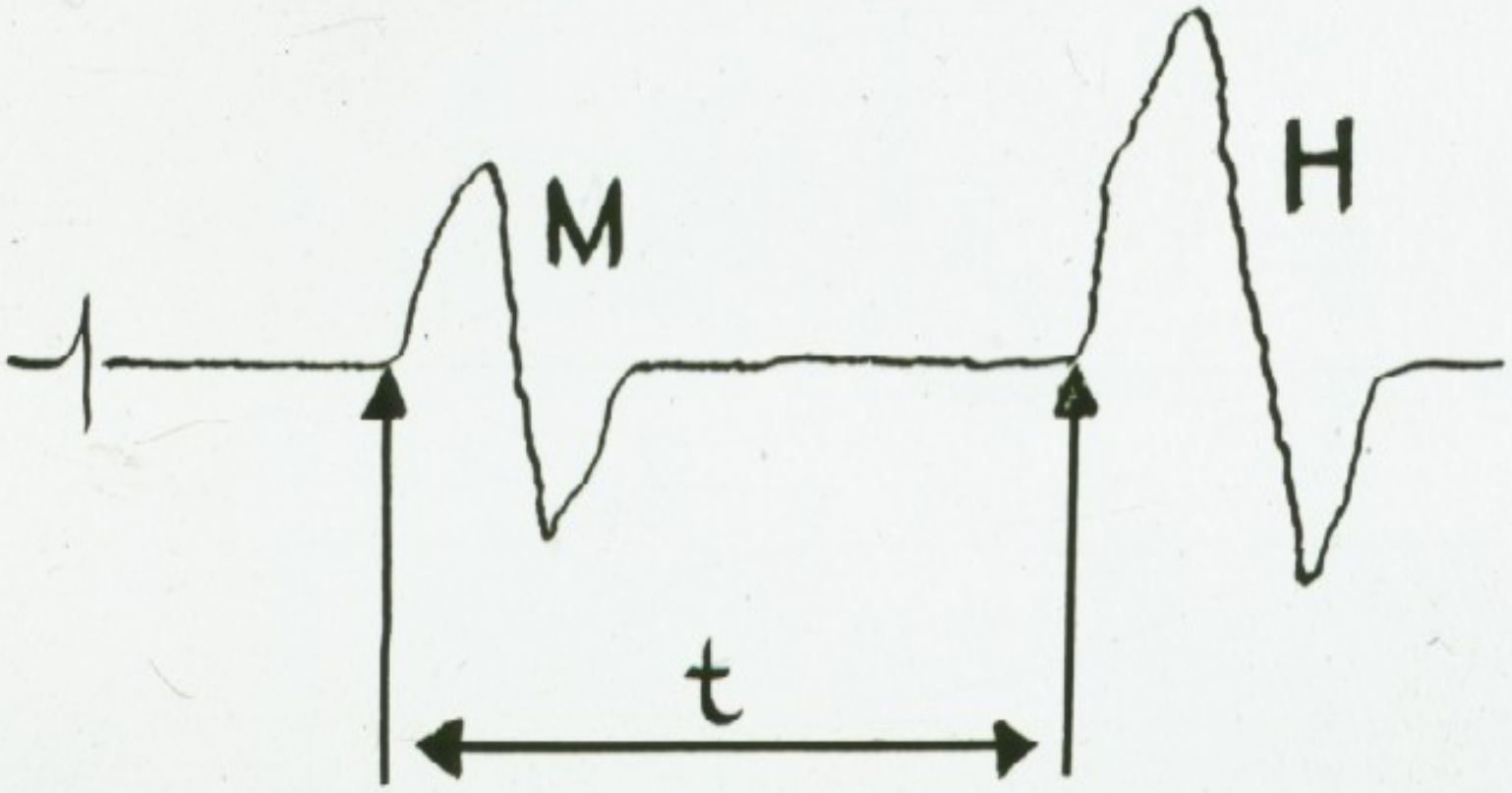
- Noterman used reflex latency to study L-S radiculopathies in 1974
- Braddom & Johnson prepared a formula to predict latency and then used it for identifying S-1 radiculopathy 1974

Noterman – H Reflex

- Studied onset of M to onset of H
- Did not differentiate L-5 from S-1

- 1974

INTERVAL LATENCY TIME (ILT)



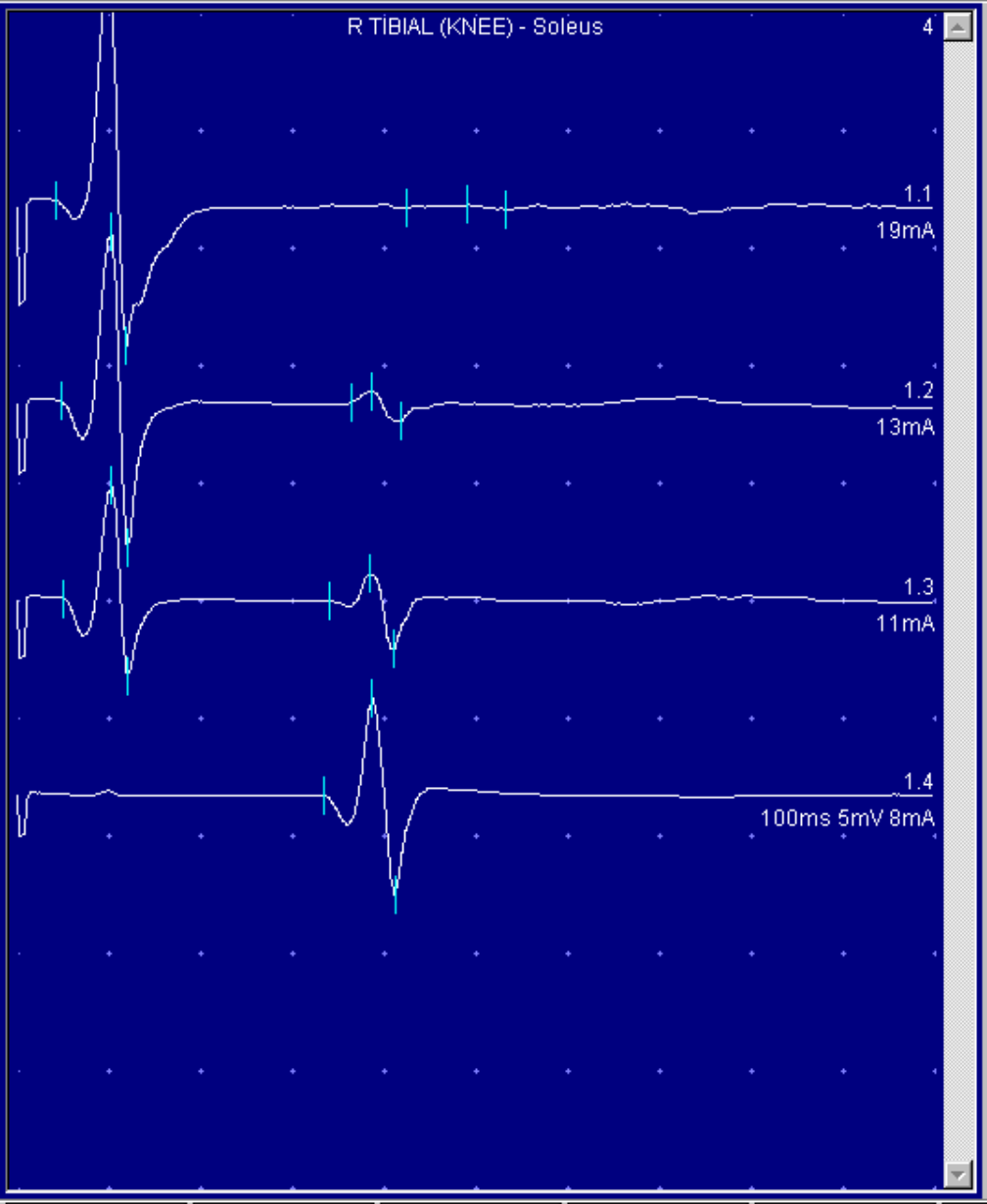
NOTERMANS 1974

Procedure (ala Johnson)

- Stimulate Tibial nerve in popliteal space (junction of middle and lateral 1/3) with a long duration (1 ms) low intensity current.
- Recording electrodes – E-1 over lateral dista1/3 of leg and E-2 over achilles tendon
- Repeat stimuli at LOW frequency
- H must be larger than M wave if M is present

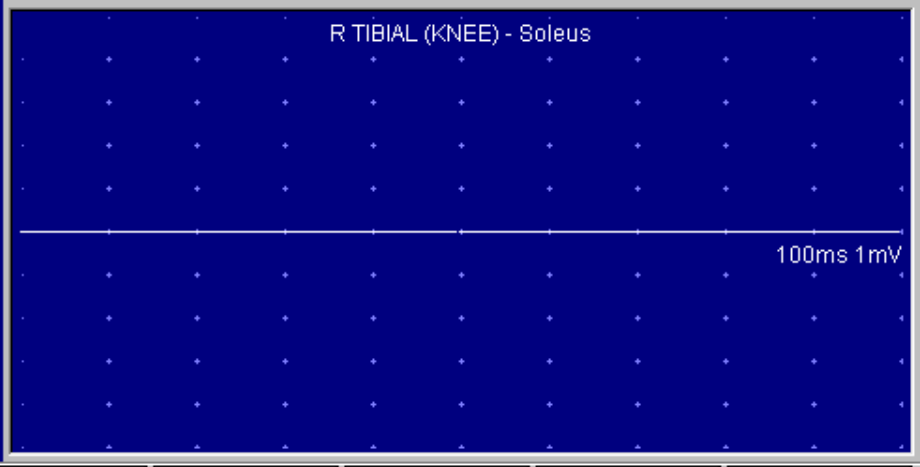
File System Display Acquisition Stimulus Analysis Results Catalog Help

Stim.B 7.8mA Dur.B 1ms 0.5pps °C



R TIBIAL (KNEE) - Soleus

Stats	Resp. No	H Lat. ms	H Amp. mV
Max H	4	33.45	4.2



F1 New Nerve | F2 Test Menu | F3 Motor NCS | F4 Tr. Sensitivity | F5 Results | F6 S. Impose | F7 Mark Toolbar | F8 Auto Comp. | F9 Comments | F10 Print

Formula to calculate H latency

- .46 X distance from stimulation to medial malleolus
- + .1 age in years
- + constant – 9.14

- Difference side to side > 1.0 ms (conservative)
- My opinion is > .5 ms is “red flag”

Radiculopathy

Predicted H-Reflex Latency

$$= 0.46 \bullet L + 0.1 \bullet A + 9.1$$

Where

L=Leg length in cm

A=Age in years

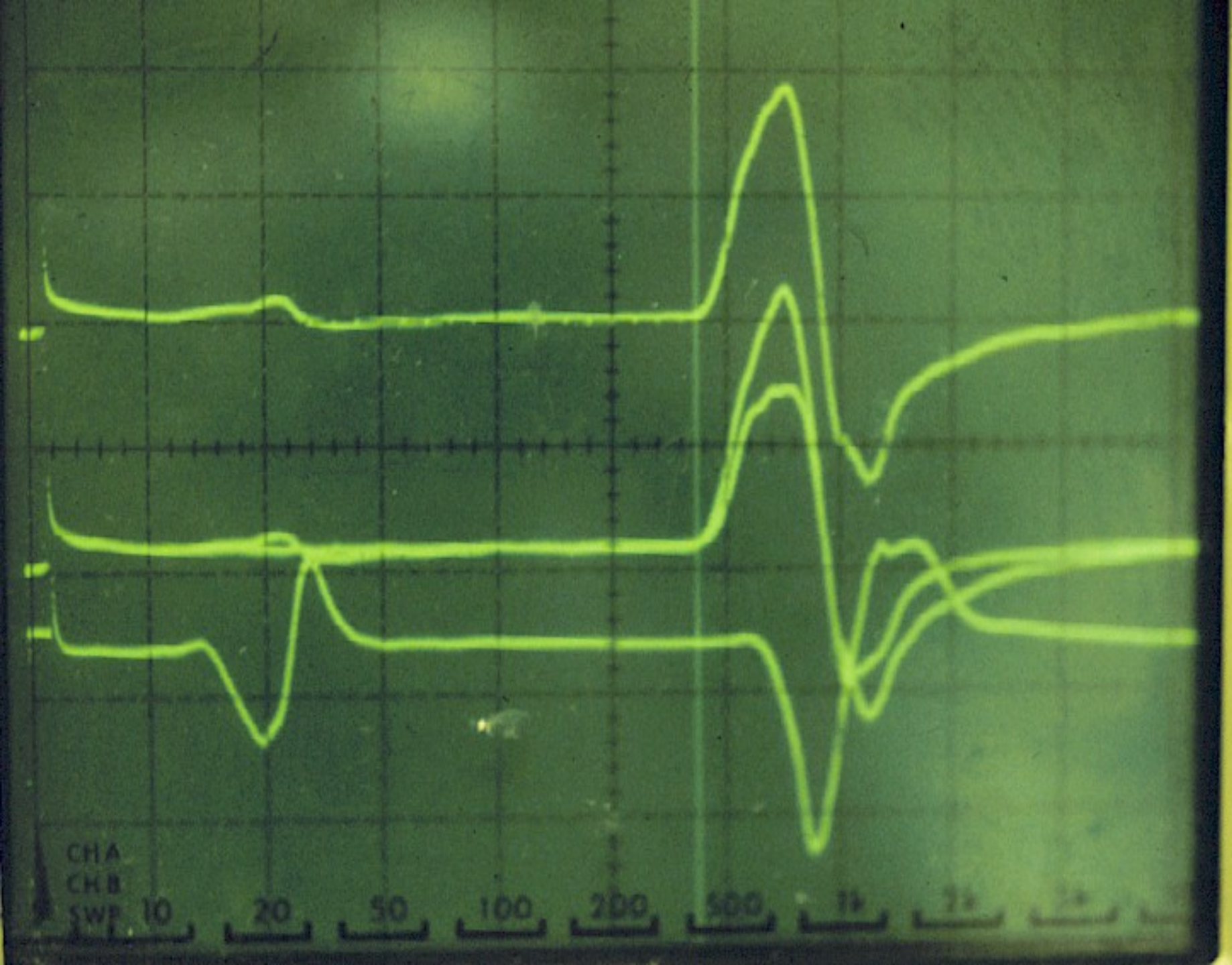

STIM
GROUND
ACTIVE
REF

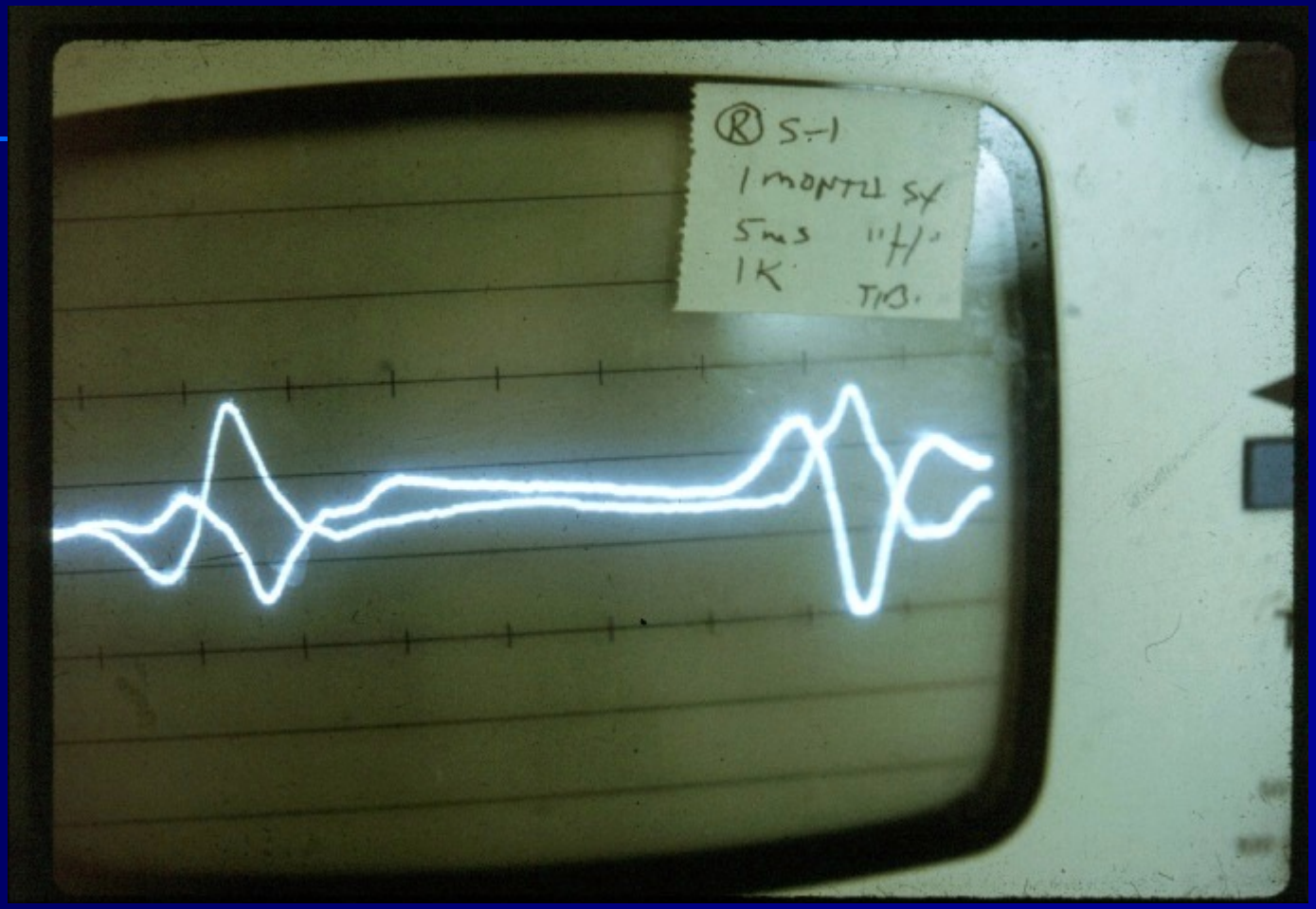
‘H’ REFLEX LATENCY IN LUMBAR RADICULOPATHY

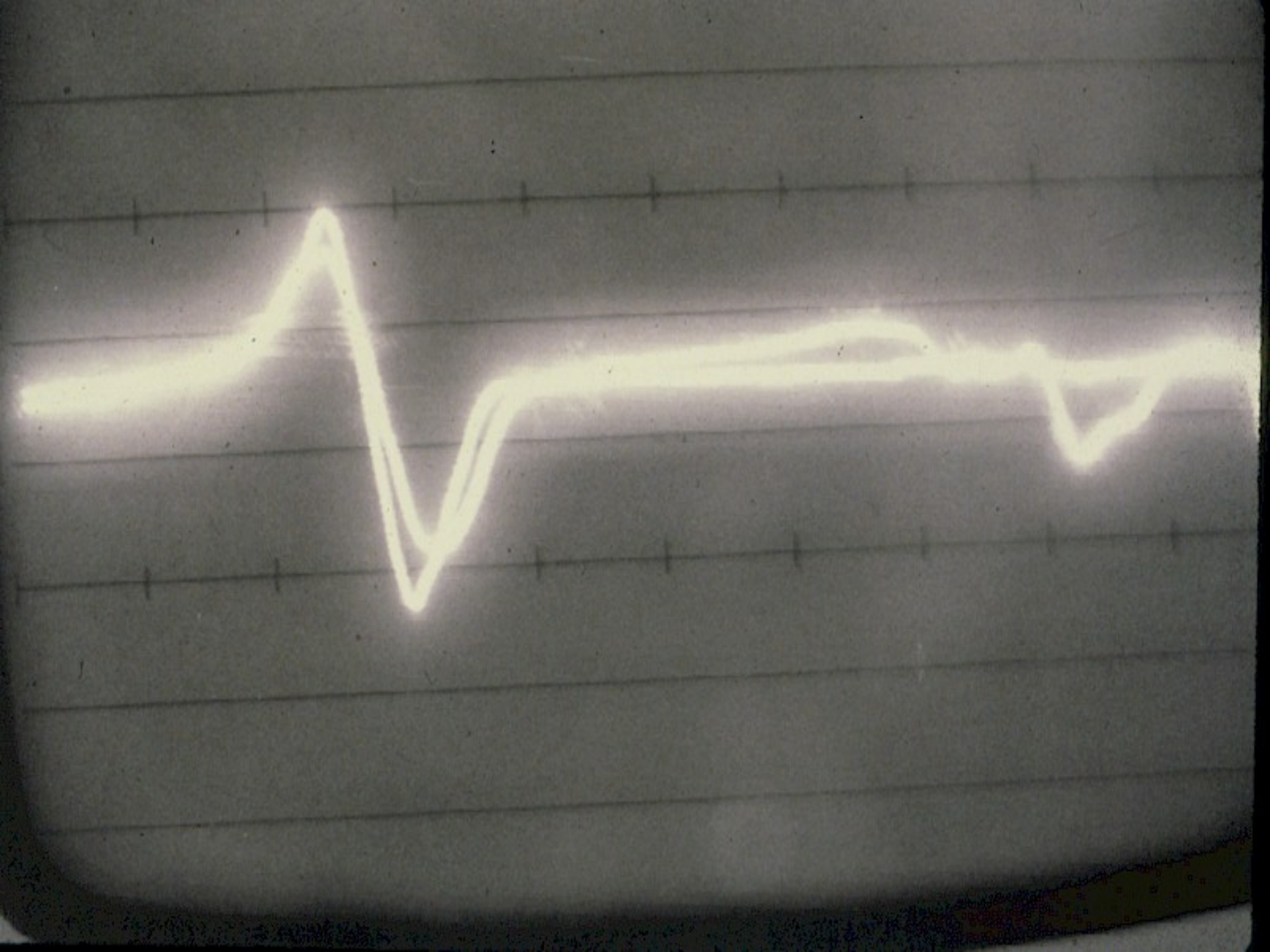
- Will be prolonged in S-1 radiculopathy from the onset of radicular pain
- Difference in latency, side-to-side, =or< 1 millisec or even .5 millisec is a red flag.
  - Original study (1974) mean 2 st.dev. =
  - .8 ms (3 st. dev = 1.4 ms)
  - More recent series difference side-to-side .3 ms

Why calculate ‘predicted latency’?

If determined is greater than predicted ***bilaterally*** (but same: side to side) – one should consider underlying peripheral neuropathy.


CH A
CH B
SWP
10
20
50
100
200
500
1k

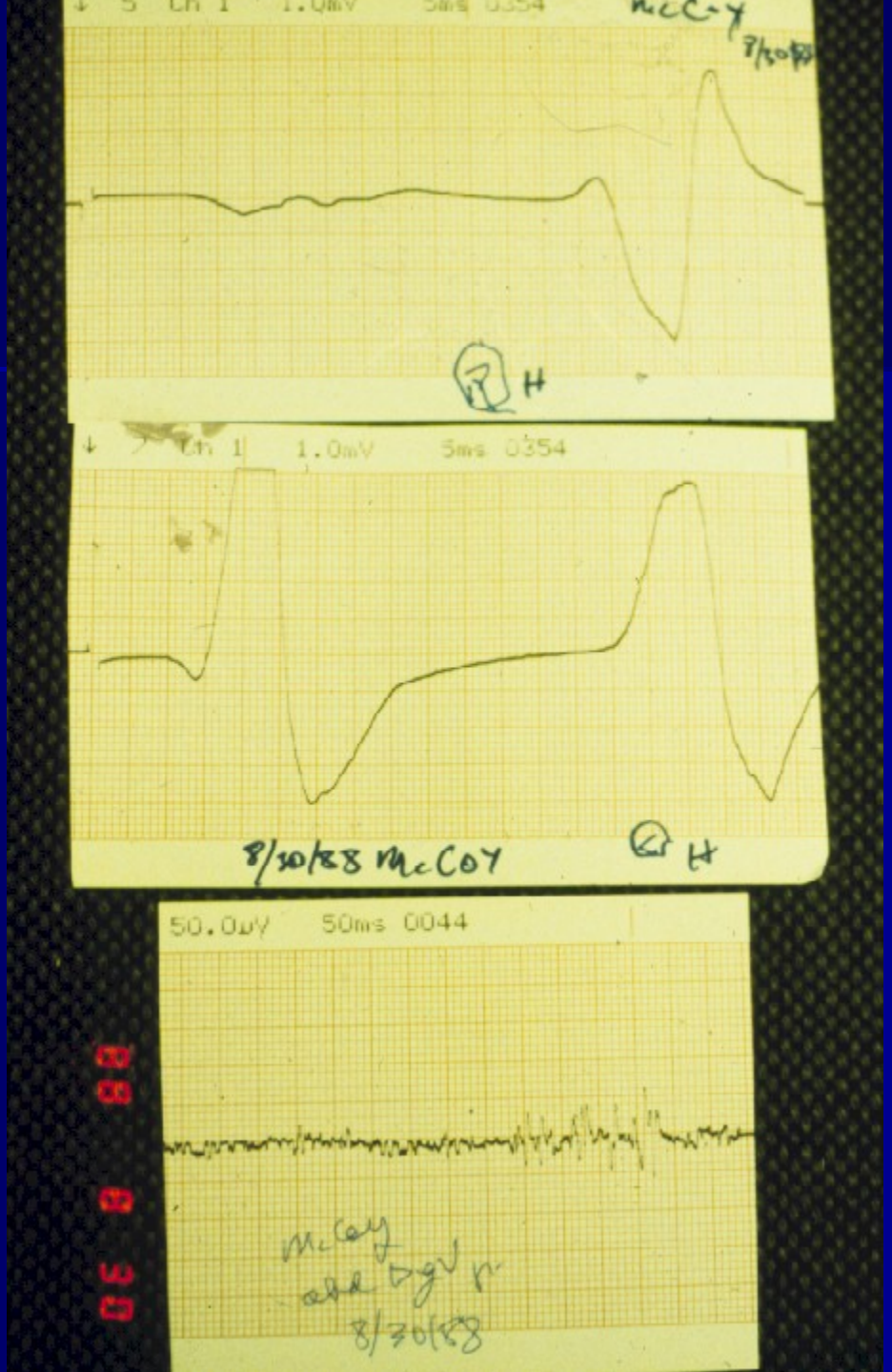

R S-1
1 MONTEL SY
5ms
1K
TIB.



McCoy
8/30/88
H

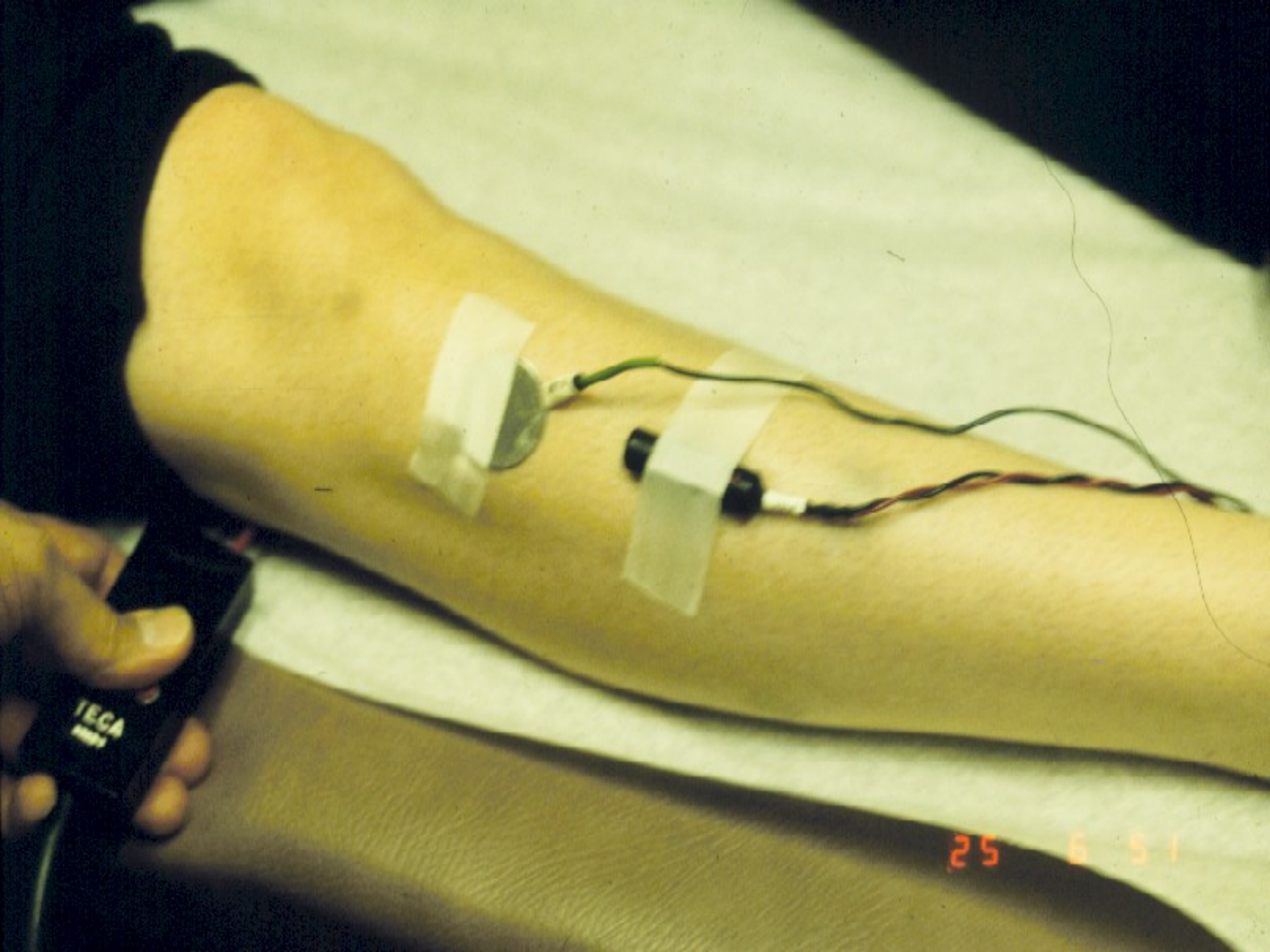
Ch 1 1.0mV 5ms 0354
8/30/88 McCoy
H

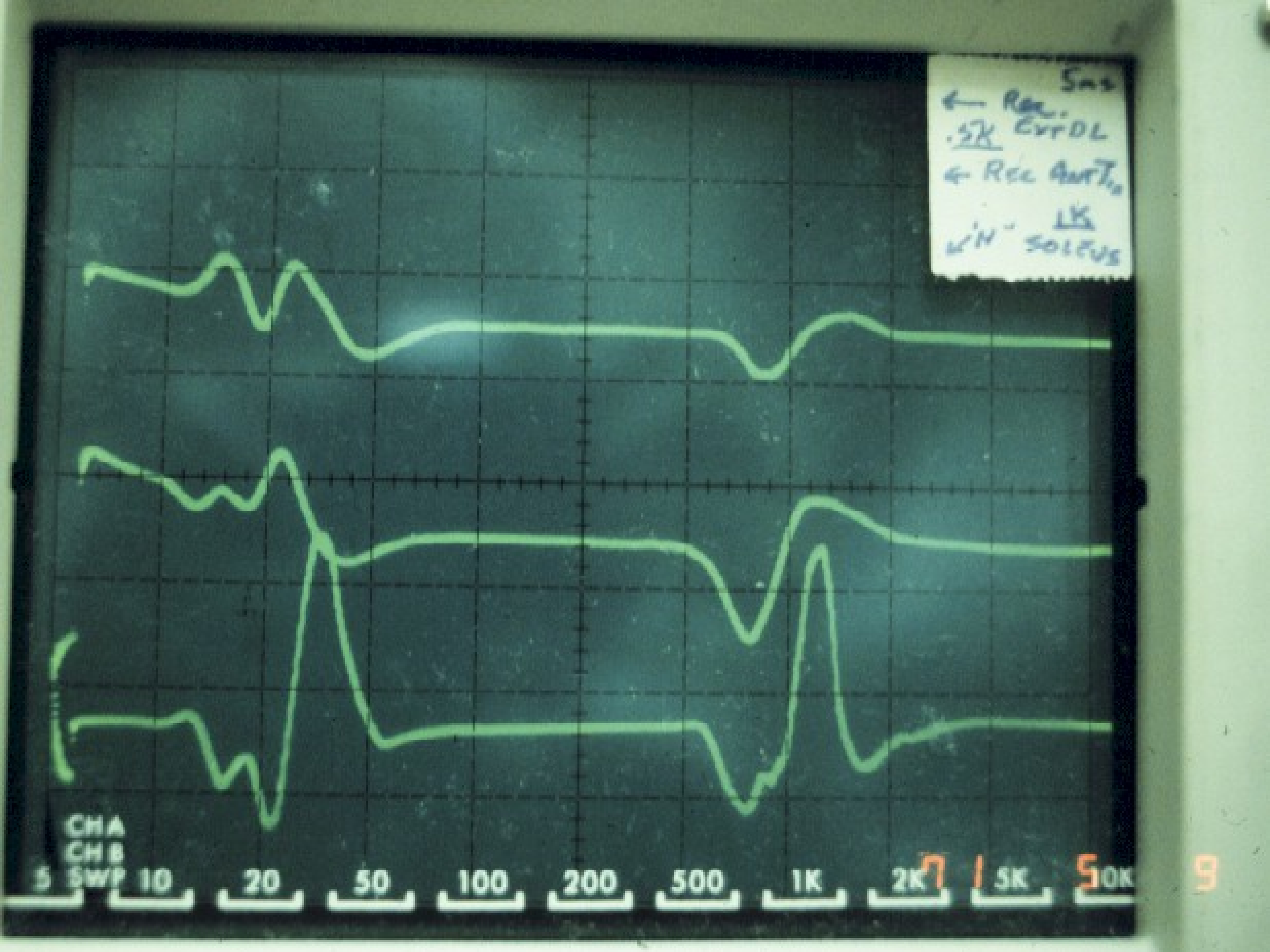
50.0uV 50ms 0044
McCoy
8/30/88


OCT 8 88

We are recording from SOLEUS

This is a large muscle and one can record it from any position around leg


IEGA


5ms
CHA
CH B
SWP
5 10 20 50 100 200 500 1K 2K 5K 10K

H reflex - Influences

- Facilitate –
  - Slight contraction of agonist
- Depress –
  - Contraction of antagonists
  - Strong co-contraction
  - Unreliable parameter in conscious person

  - Ref: McHugh,Reeser, Johnson: Am J PM&R 1994

H ampl change With muscle activity

Figure 1. Electrodes positioned for H reflex latency determination. Note stimulation is with the monopolar needle to ensure identical intensities.

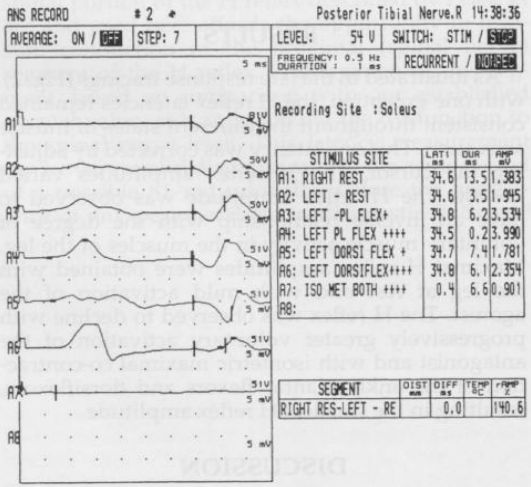


Figure 2. H Reflex tracings. Note variations in amplitudes but consistent latencies and stimulation intensities.

a prolongation of the H reflex in S1 radiculop has been postulated to result from focal demy ation or selective loss of fast-conducting fibe Braddom and Johnson[6] developed a formula which the expected H reflex latency may be mated, based on limb length and patient age.

This is a single case study demonstrating tha H reflex amplitude is an unreliable parameter evaluating the S1 nerve, because it is significa influenced by the amount of muscle activity pre in the muscles of the leg. H reflex amplitude found to decline with increasing strength of ant nist (foot dorsiflexors), as one would expect, there also was an abolition of H reflex with max co-contraction of agonist and antagonist.

Because the electrode placement remained changed and the stimulation intensity remained same, as one would expect, reflex latencies constant throughout the study; however, the cha in H reflex amplitudes can be attributed to varia in activity of the leg muscles. Activation of ant nists reduced the amplitude; mild activity of agonist increased the H reflex amplitude, and vig ous co-contraction of agonist and antagonist duced the amplitude.

H reflexes have been shown to be enhanced activities that increase motoneuron excitabil Verrier[9] demonstrated augmentation of the H re amplitude in the flexor carpi radialis by varying baseline electromyographic excitability.

Tanaka[10] reported depression of the H reflex both voluntary ankle dorsiflexion and with pe neal nerve stimulation; he reported facilitation the H reflex amplitude with voluntary ankle plan flexion. Also, using peroneal nerve stimulat Shinodo et al.[11] found an inversely decrement response of H reflex amplitude with the strength ankle dorsiflexion. Jankus et al.[12] proposed rather than absolute amplitude, the ratio of side side H reflex amplitudes may be useful to det abnormalities in subjects with otherwise norma reflex latencies.

In the present study, activation of the leg muscl both ankle plantar flexors and dorsiflexors, wh constant tibial nerve stimulus intensity, was o served to have no significant effect on the H re latency but did result in a diminished H re amplitude. This most likely reflects inhibition of soleus motoneurons by the ankle dorsiflexors a elevation of the late response threshold with incre ing strength of contraction in the agonist muscle

Murphy et al.[13] reported that the H reflex amp tude decreases following sacroiliac joint manipu tion and postulated that the decrease resulted fr reduced excitability of the S1 alpha motoneu because of diminished motor afferent input. A study suggests that changes in H reflex amplitu

Surrogate “H”

Use mean of 10 F waves

F & H in L/S Radiculopathy

- If can't get H Reflex
  - Change gain to 200 uV and stimulus duration to .1 ms
  - Get 10 F waves
    - Mean of 10 is 1.8 ms longer than ipselateral H latency
    - Side-to-side difference of mean of 10 F waves - .6 ms

Use of H reflex latency

- Early in course of L/S radiculopathy
- When abnormal irritability is only in paraspinals
- Underlying peripheral neuropathy (diabetic)
- If muscle exploration is confusing
- Post laminectomy with recurrent symptoms

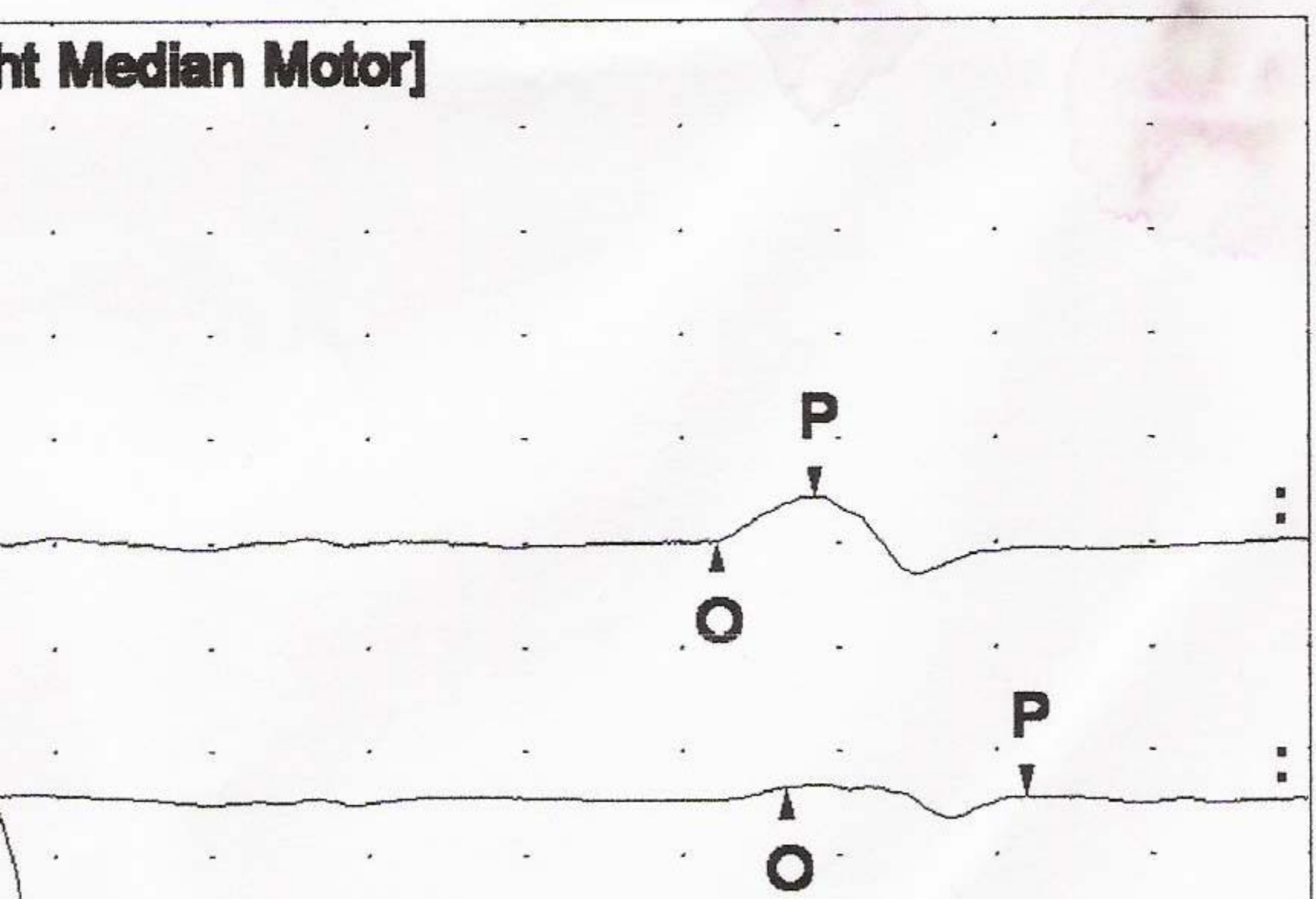
Use of H reflex latency when positive waves are only in paraspinals

- 90 – 95% of all first appearing radiculopathies are L-5 or S-1
- Ratio of frequency – L-5:S-1 = 2:1
- H latency is prolonged – S-1; if normal – L-5

Other uses for H Reflex

Other than S-1 radiculopathy

3.3	1.4	9.22	3.3	0.0



H reflex in Huntington disease

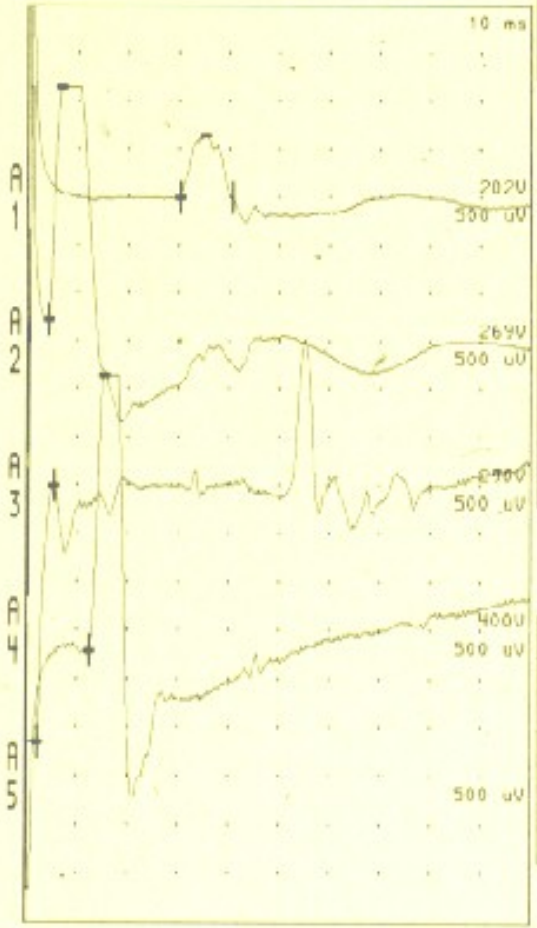
- In discussions with Geoge Paulson about early identifying children from HD parent, we suggested that since the corticospinal tracts are involved in this condition – H reflex could be a diagnostic indicator
- If H reflex could be elicited in peroneal or other peripheral nerve than tibial, this could be an early marker.
- We found the H reflex present in anterior tibial muscle in 8/9 persons with HD and in 5/8 persons at risk (ie. progeny of HD parent).

MNC RECORD # 1 13y/o .R Open 12:09:51

Switch: N-R Stim: 1	Rate:Non-Recurrent	Level: 400 V	Dur: 0.2 ms	Single

Step: 4	Average: Off	Rectify: Off
Trace Delay: 0 ms		

Birth Date: 6 JUL 91 Female
Exam. Date: 31 DEC 96 Age: 5Y 178D



Recording Site :

STIMULUS SITE		LATI ms	DUR ms	AMP mV	AREA mVms
A1: "H"	Abd Pollicis	30.1	10.6	0.662	4.308
A2: M	" "	4.2		OFL	
A3: H	FDS	2.2	3.2	OFL	OFL
A4: M	FDS	12.4		OFL	
A5:					

SEGMENT	DIST mm	DIFF ms	CV m/s
A1-A2		25.9	
A2-A3		2.0	
A3-A4		10.2	
A4-A5			

Children's HOSPITAL

H reflex in peroneal nerve (anterior tibial)

- 34 y/o lady presented with unilateral limp
- Operated (arthroscopy) for torn meniscus
- Drop foot seemed to have appeared after surgery
- EDX – H reflex in anterior tibial when peroneal nerve stimulated. No abnormal irritability in limb muscles. BUT positive waves present in mid dorsal paraspinal muscles (also + babinski)
- Then – MRI - massive HNP at T-6,7

STIM. PER N

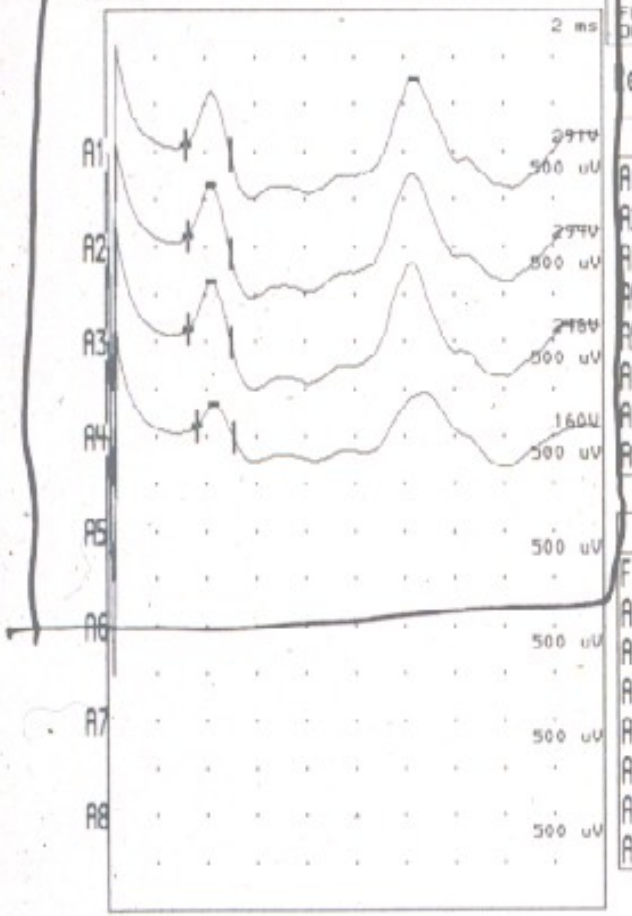
Record ANT TIB

ANS RECORD # 1 [redacted] [redacted] 12:30:46

AVERAGE: ON / OFF | STEP: 4 | LEVEL: 160 V | SWITCH: STIM / STOP

FREQUENCY: 0.5 Hz
DURATION : 0.1 ms | RECURRENT / NONREC

Recording Site : ~~Flex carpi rad.~~ [redacted]



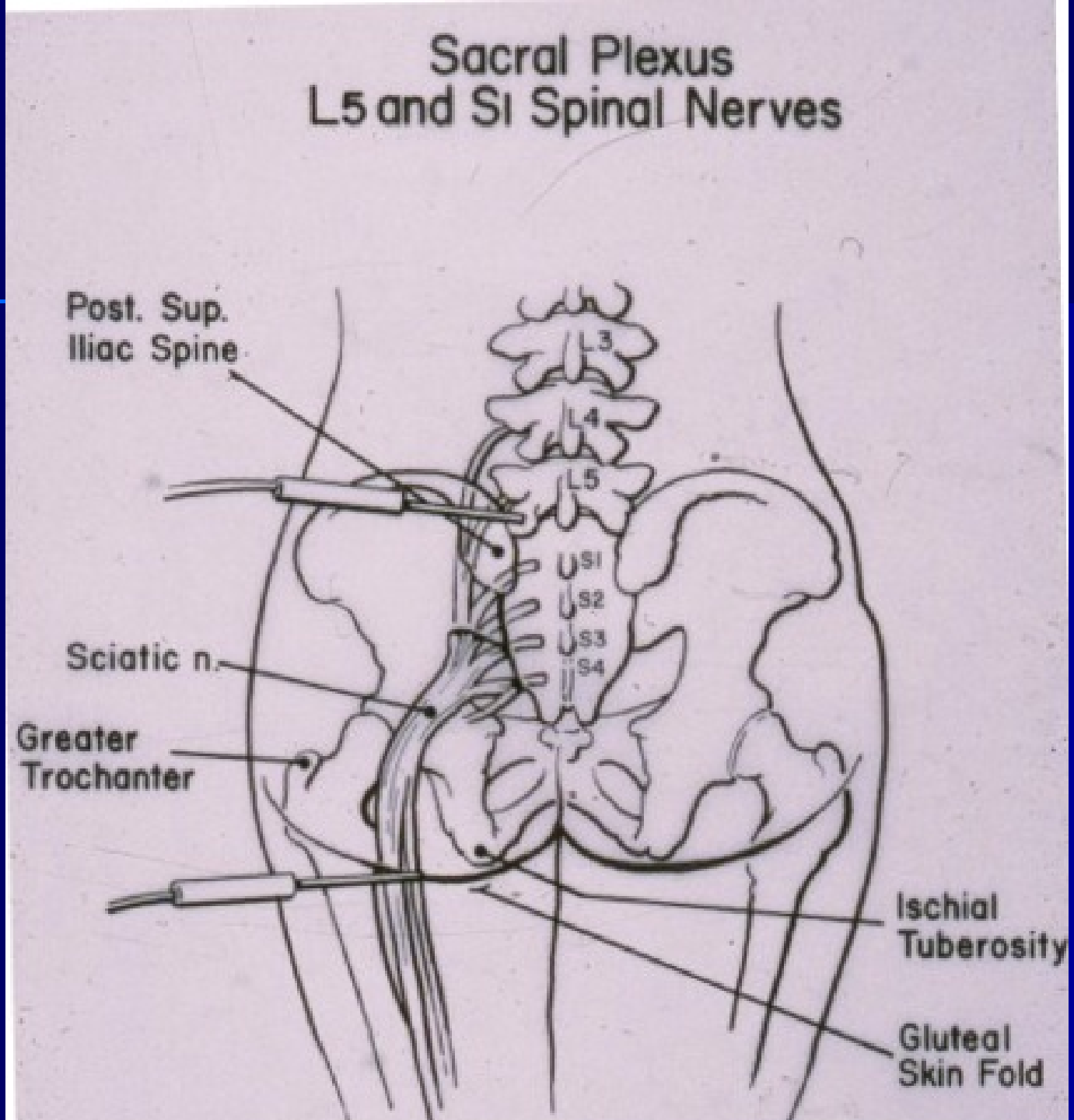
STIMULUS SITE	LAT1 ms	DUR ms	AMP mV	AREA mVms
A1: Ante fossa	3.2	1.8	0.688	0.678
A2:	3.3	1.7	0.534	0.695
A3:	3.3	1.7	0.496	0.694
A4:	3.6	1.5	0.233	0.357
A5:				
A6:				
A7:				
A8:				

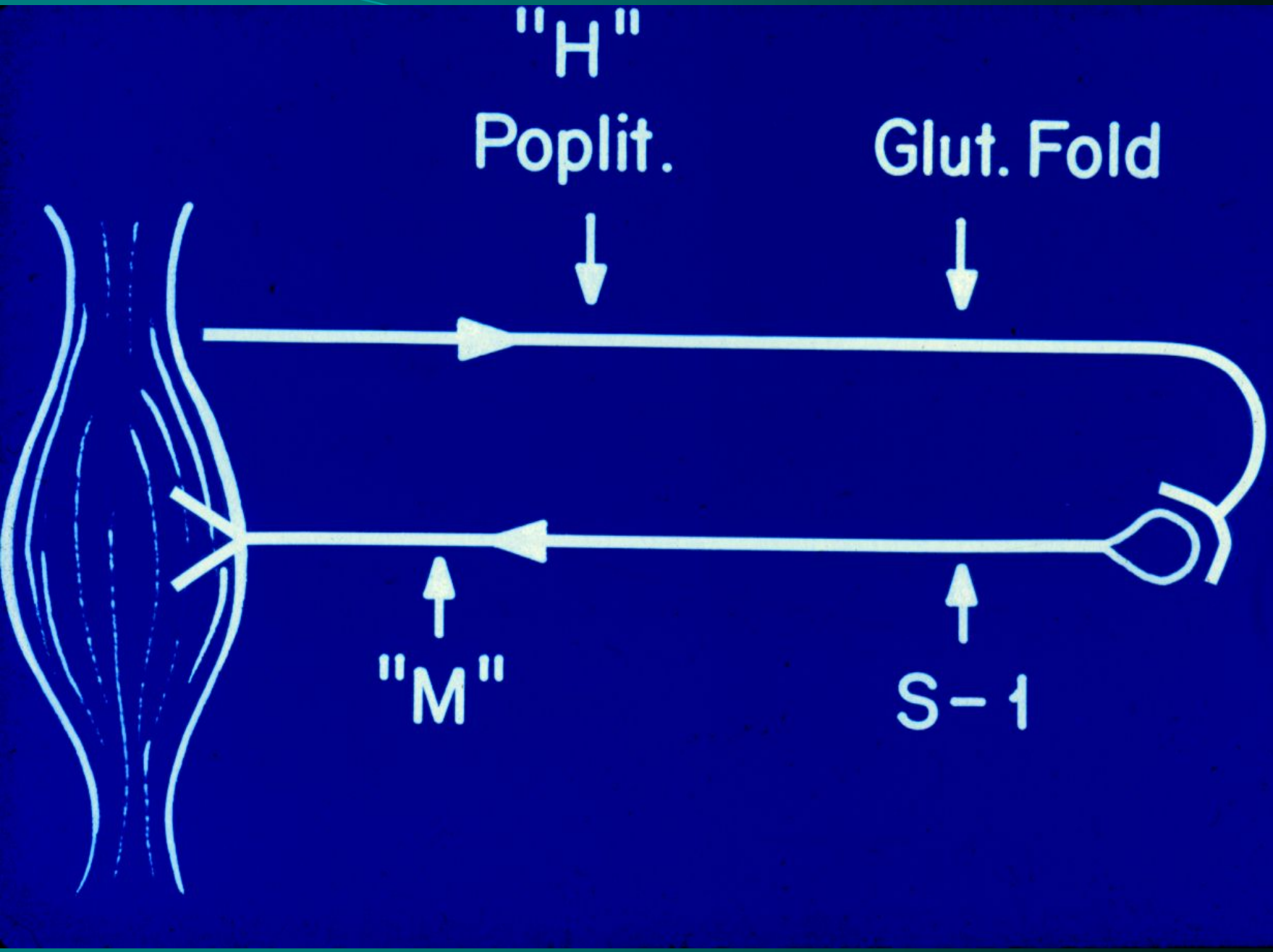
SEGMENT	DIST mm	DIFF ms	CV m/s	TEMP °C
Flex carpi-Ante foss		3.2		
Ante fossa-A2		0.1		
A2-A3		0.0		
A3-A4		0.3		
A4-A5				
A5-A6				
A6-A7				
A7-A8				

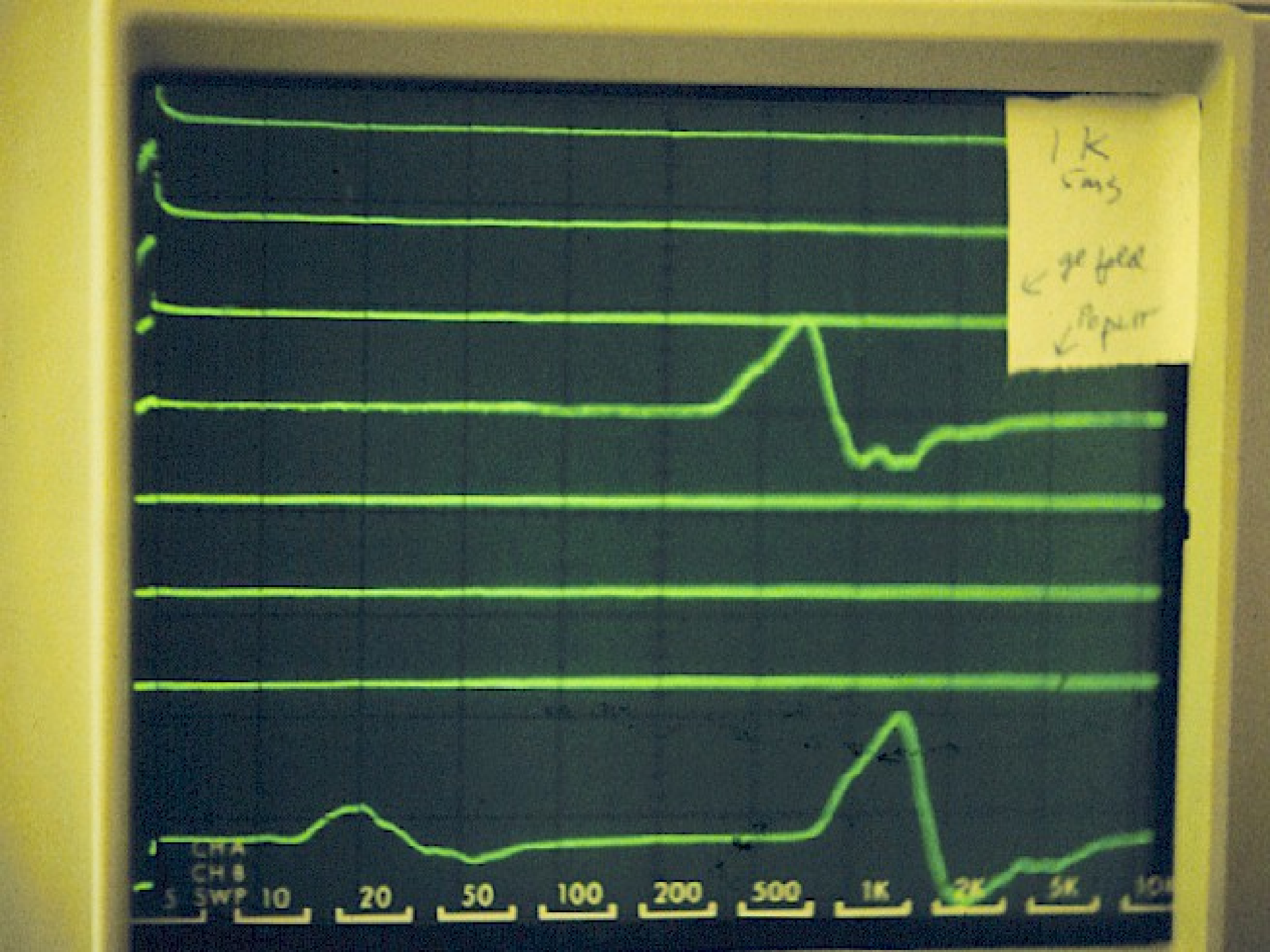
Needle stimulation of S-1 spinal nerve

- Find posterior inferior iliac spine
- Insert monopolar needle 1 cm cephalad and medial
- Apply 50 – 100 us duration stimulation for direct S-1
- Apply 500-1000 us duration stimulation for H reflex (low intensity)

Sacral Plexus
L5 and S1 Spinal Nerves




"H"
Poplit.
Glut. Fold
"M"
S-1


1K
CH A
CH B
SWP
10
20
50
100
200
500
1K
2K
5K

Needle stimulation of S-1 spinal nerve

- Find posterior inferior iliac spine
- Insert monopolar needle 1 cm cephalad and medial
- Apply 50 – 100 us duration stimulation for direct S-1
- Apply 500-1000 us duration stimulation for H reflex (low intensity)

S-1 Spinal Nerve

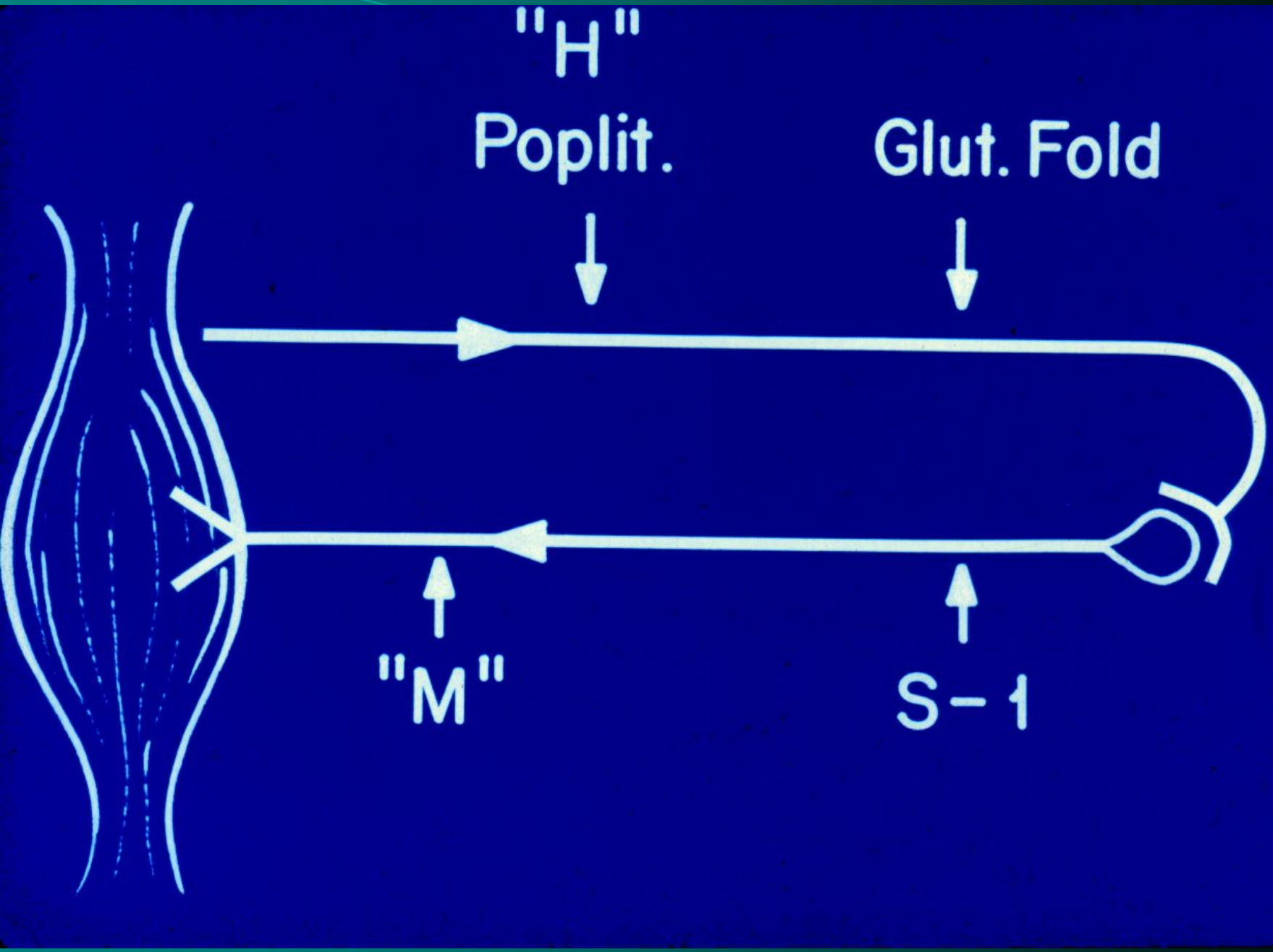
- Stimulate 1 cm medial and cephalad to posterior superior iliac spine
- Record from soleus to use in H latency
- Record from tibial muscle (Abd hall) or peroneal muscle (proximal –ant tib; distal – ext dig br)

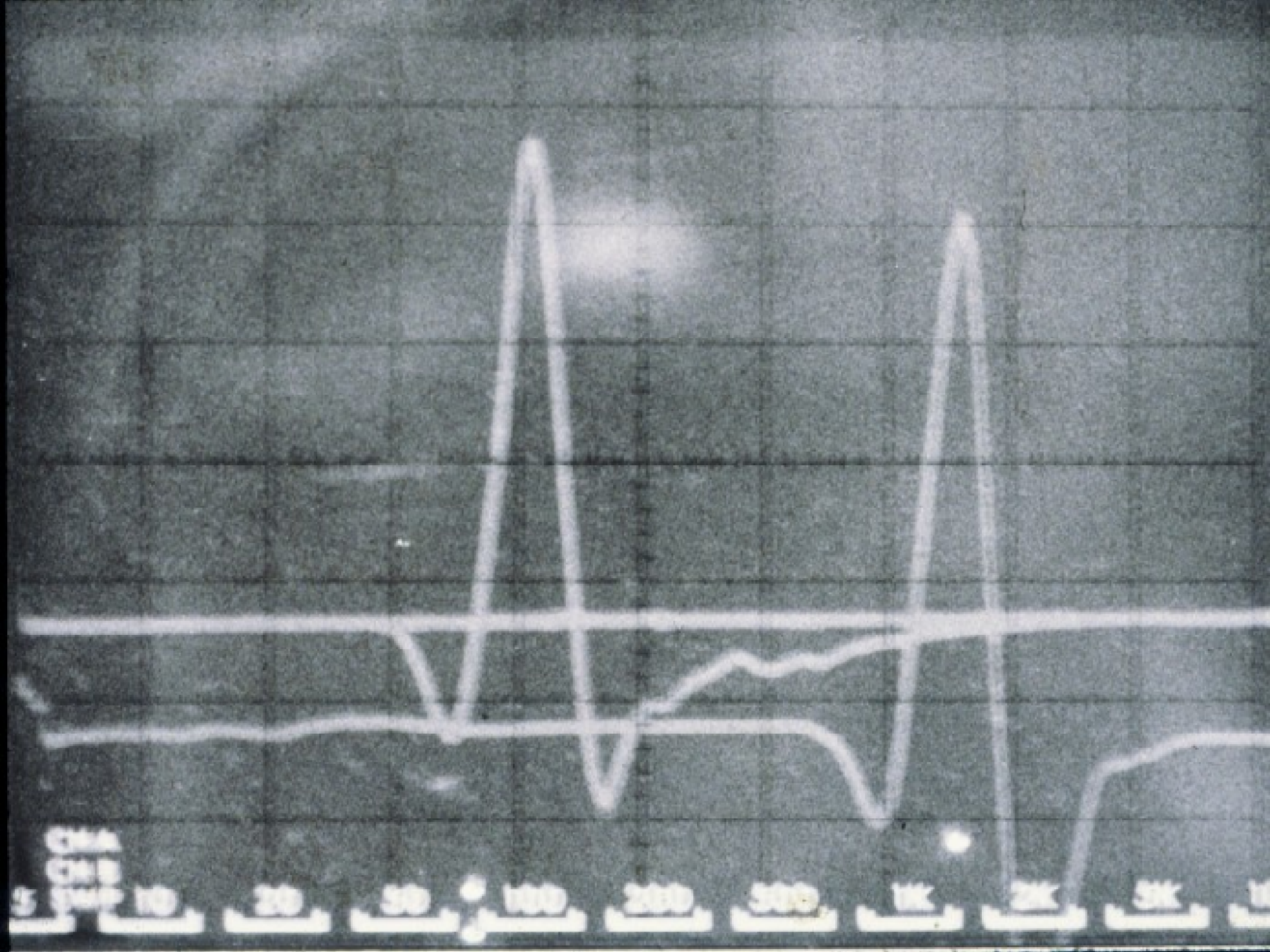
- NB. If cannot stim prox to entrapment compare contralateral muscle.

S- 1 DIRECT LATENCY VS REFLEX LATENCY

- Stimulate S-1 spinal nerve (PSIS) 50-100 uS
- Stimulate as above with 1 ms duration

- LATENCIES: S-1/H = 48% normal
- LATENCIES: S-1/H = 45% if S1 radiculopathy


"H"
Poplit.
Glut. Fold
"M"
S-1


CHA
CHB
10
20
50
100
200
300
1K
2K
3K

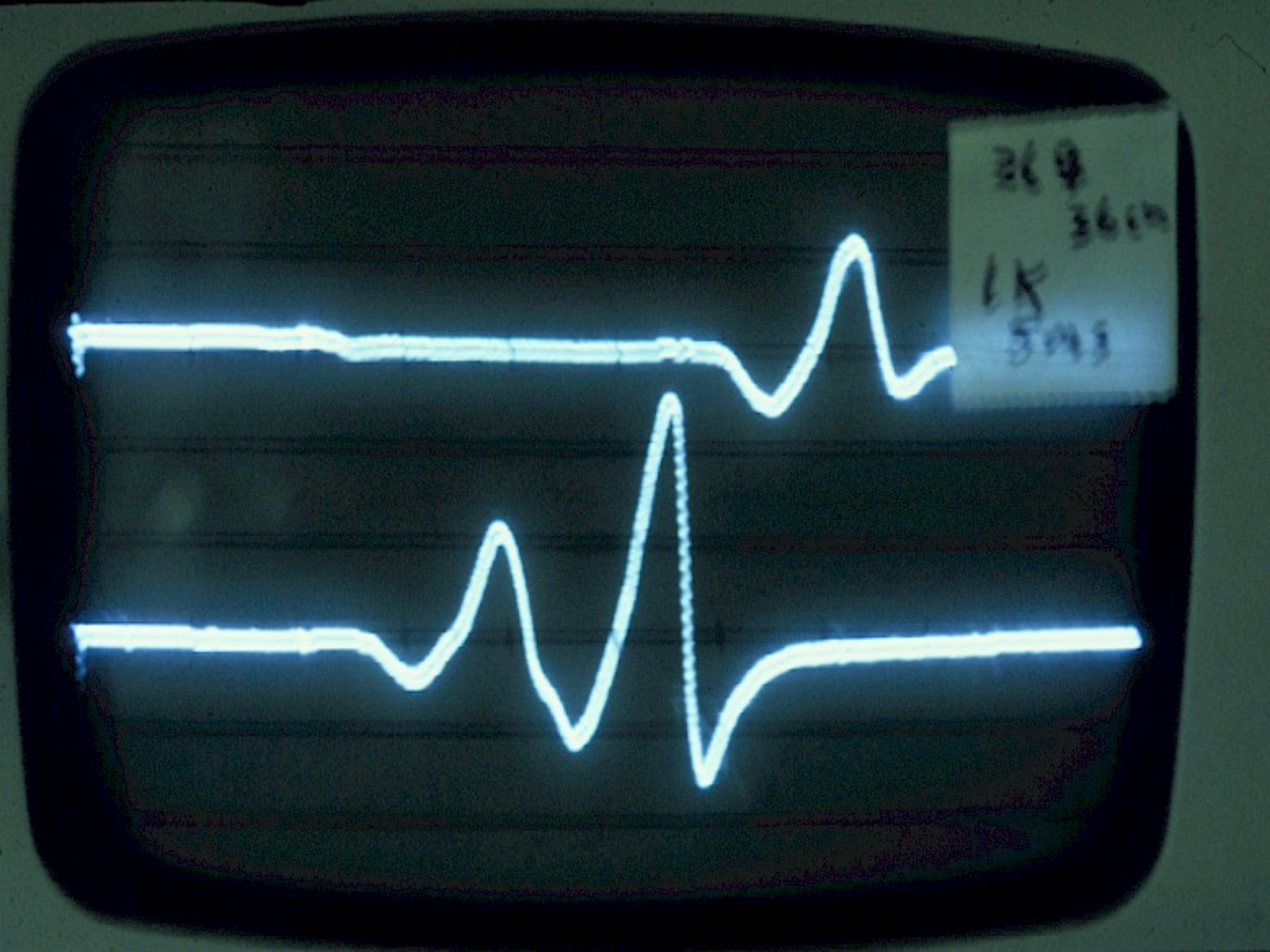
S-1spinal nerve stimulation of H reflex

- Ratio
  - Efferent limb – S-1 to soleus
  - Side-to-side difference - .16 ms (range 0-.8 ms)
  - Afferent limb – tibial nerve in popliteal fossa to H wave in soleus
  - Equals about 47%
  - If slowing at spinal nerve – ratio becomes <45%


CH A
CH B
SWP
10
20
50
100
200
500
1K
2K
5K
10K

S-1 Spinal nerve in H latency

- Record from soleus
- Stimulate with 1 ms duration and low intensity to get an H wave from afferent orthodromic impulse and CMAP (M) efferent motor to soleus


2k Ω
36 cm
1K
5ms

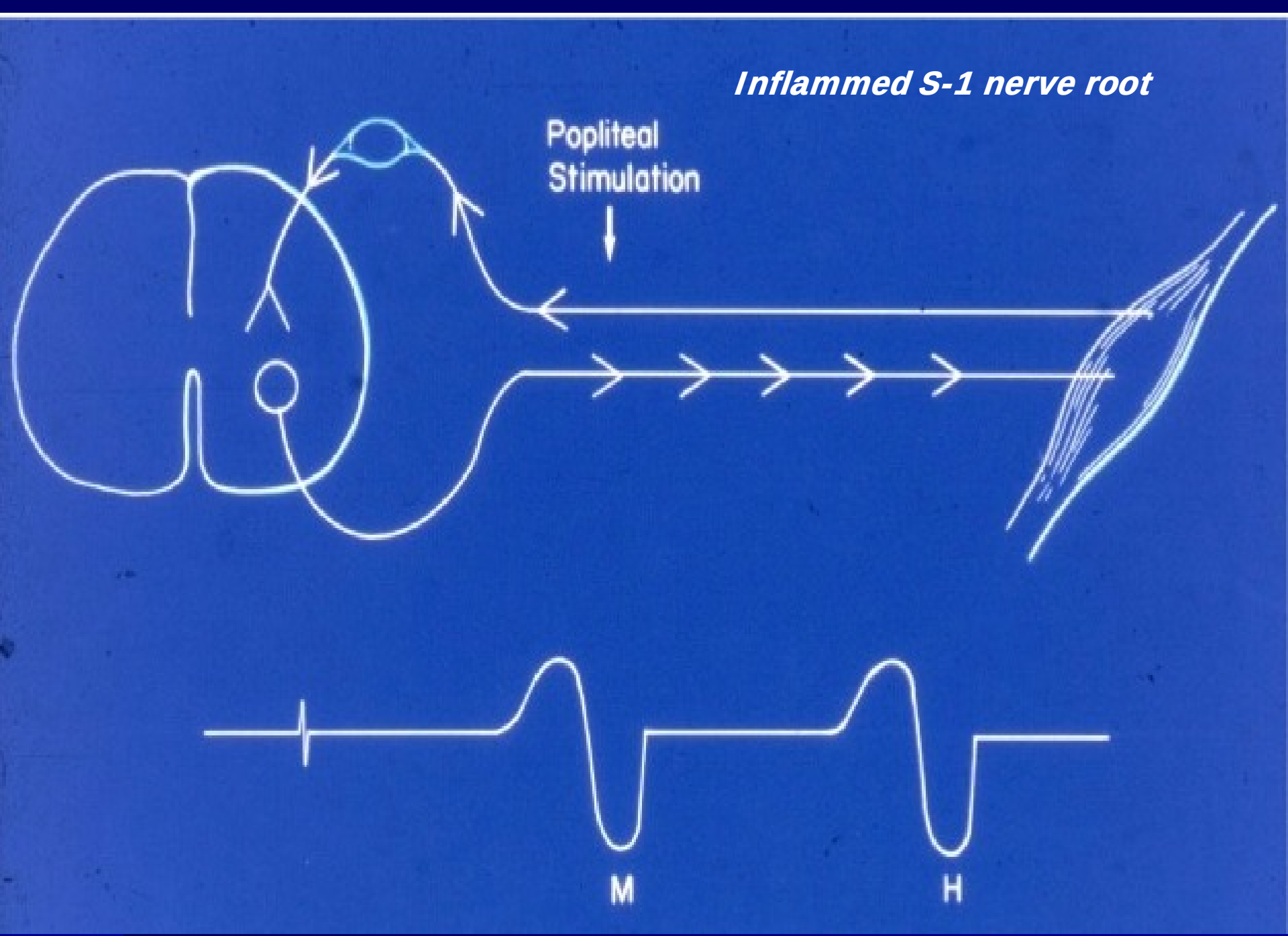
S-1 spinal nerve H reflex

- Stimulate with 1 ms duration and low intensity
- H wave will appear 1st and M wave following by 6-8 ms
- If take-off appears for M wave, there is usually more than 8- 9 ms between H & M


↓ 4 Ch 1 500.0uV 5ms 0354 T1
↓ 3 Ch 1 1.0mV 5ms 0354 T1
M H S-1 STIM

S-1 spinal nerve stimulation and *central loop*

- If stimulation duration at spinal nerve is I ms:
  - Both efferent arm and afferent arm will be stimulated
    - Soleus CMAP will appear 1st and H wave will appear 2d
    - Time between the two waves will be the rate of speed nerve impulse travels thru “central loop”

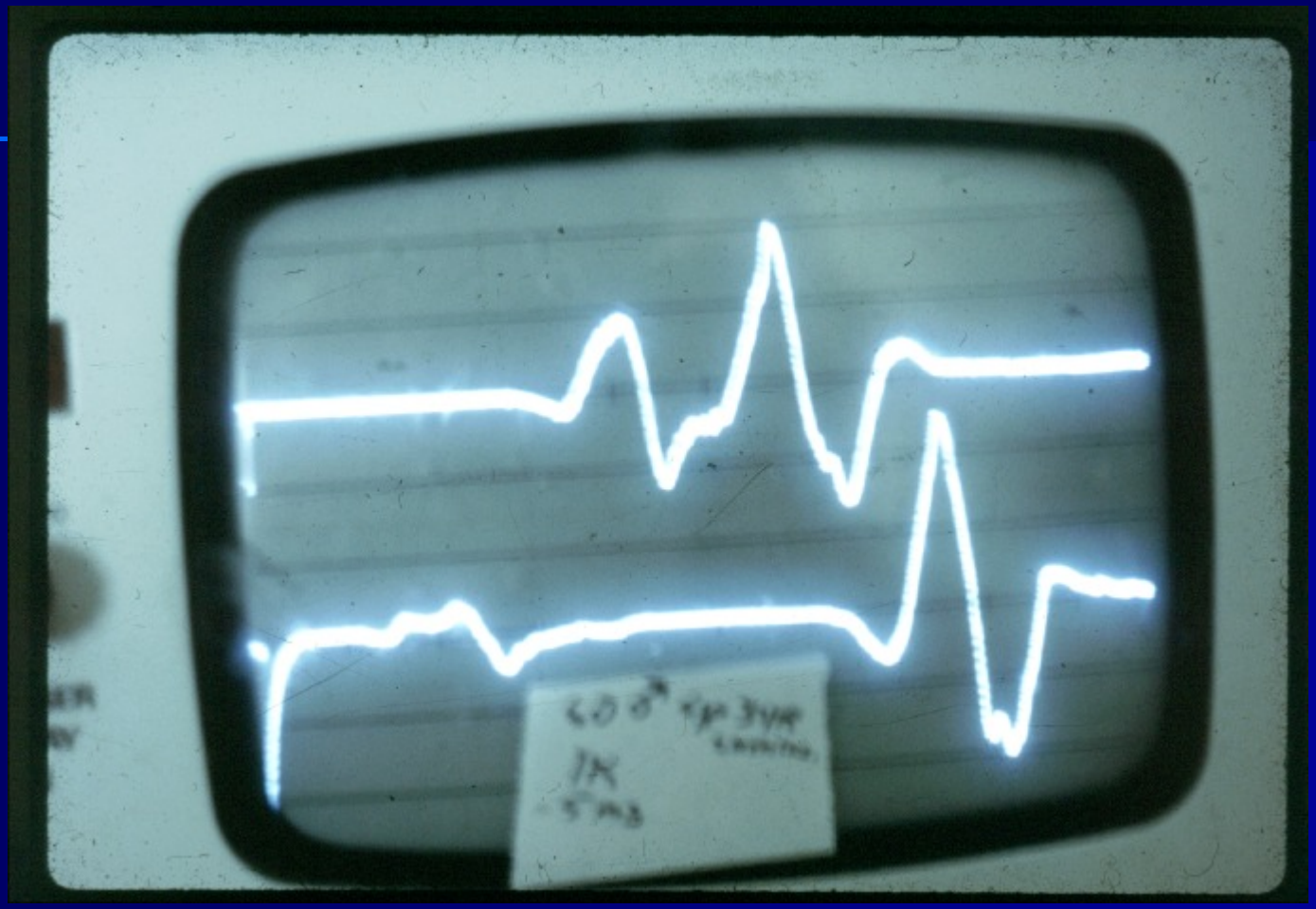

Inflammed S-1 nerve root
Popliteal
Stimulation
M
H

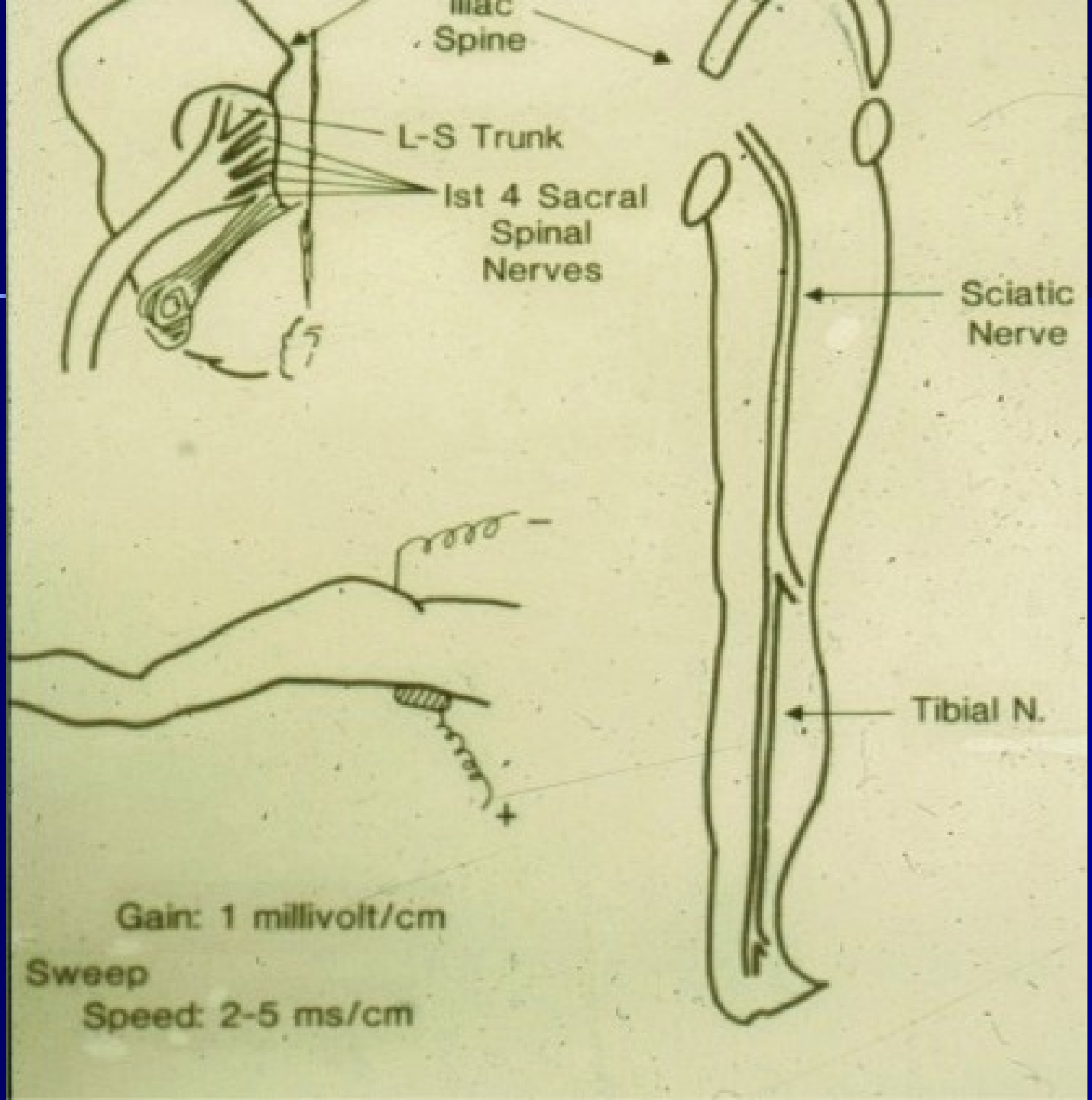
Central loop values

Normal – 7-9 ms

- Probable S-1 radiculopathy (or proximal tibial nerve compromise) >9 ms

- NB. If H wave can be seen with a “take-off” it is likely that central loop time is prolonged




Iliac
Spine
L-S Trunk
Ist 4 Sacral
Spinal
Nerves
Sciatic
Nerve
Tibial N.
Gain: 1 millivolt/cm
Sweep
Speed: 2-5 ms/cm

H reflex latency in L-5 radiculopathy

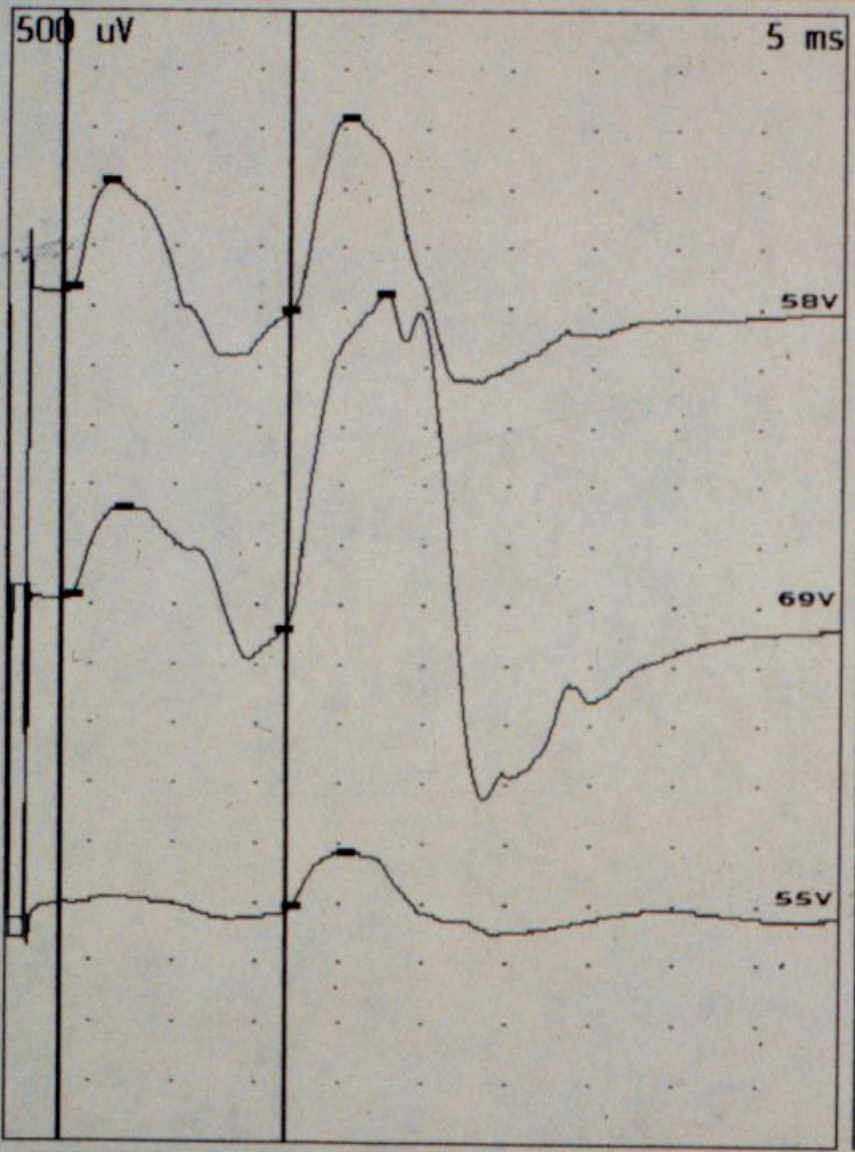
- H reflex was performed on patients with EMG evidence of L-5 radiculopathy
  - N = 25
  - Difference R/L = .11 +/- .08 ms
  - L-5 – EMG abnormalities in ant tib; ext dig long;
  - S-1 – EMG abnormalities in soleus, abd hall

H reflex in upper limb

- Stimulate median nerve in antecubital space
- Record with surface electrodes over flexor carpi radialis
- Use long duration stimulation (.5-1 ms)
- Probably slow in C-7 radiculopathy

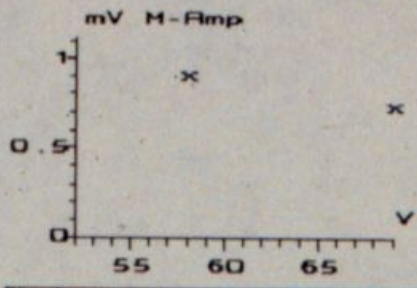
H-WAVES RECORD # 2 John J. Smith
Data on Local Hard Disk
Median nerve
Flexor carpi rad
15:11:00

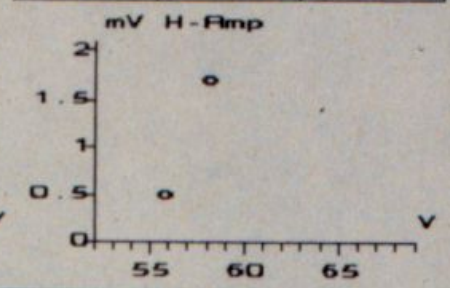
Switch: N-R Stim: 1	Rate: Non-Recurrent	Level: 196 V	Dur: 1 ms	Single

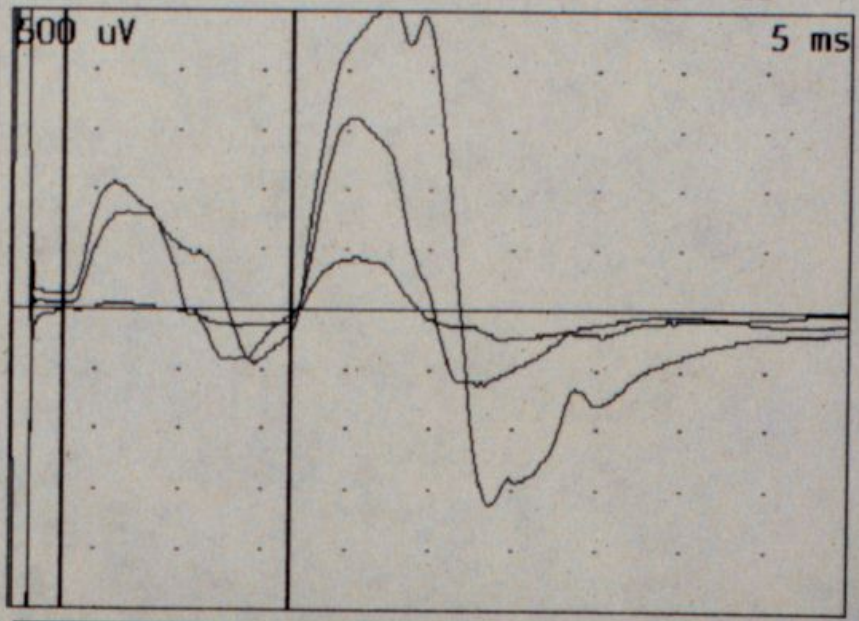


Trace: Hold/ 3
Trace Delay: 0 ms
Distance:
Stim: Elbow
Birth Date: 1 JAN 40 Male 6'2"
Exam. Date: 31 JAN 96 Age: 56Y 30D

	Lat ms	Amp mV
M-wave	3.2	0.980
H-wave	16.8	1.659







No of Traces: 3
Min H-Lat: 15.0 ms
Recurrent
Non-Recurrent
Dur: 1 ms
Rate: Non-Recurrent
Amp Markers: On
Reanalyze
SNS: 500 uV

references

- Braddom, R & Johnson, E: H reflex: review and classification with suggested clinical uses. 1974 Arch PM&R. 55:412
- Braddom, R & Johnson, E: Standardization of H reflex and diagnostic use in S-1 radiculopathy. 1974. Arch PM&R. 55:161
- McHugh, D et al: H reflex amplitude: Effect of leg muscle activity. 1997. Am J PM&R. 76:185

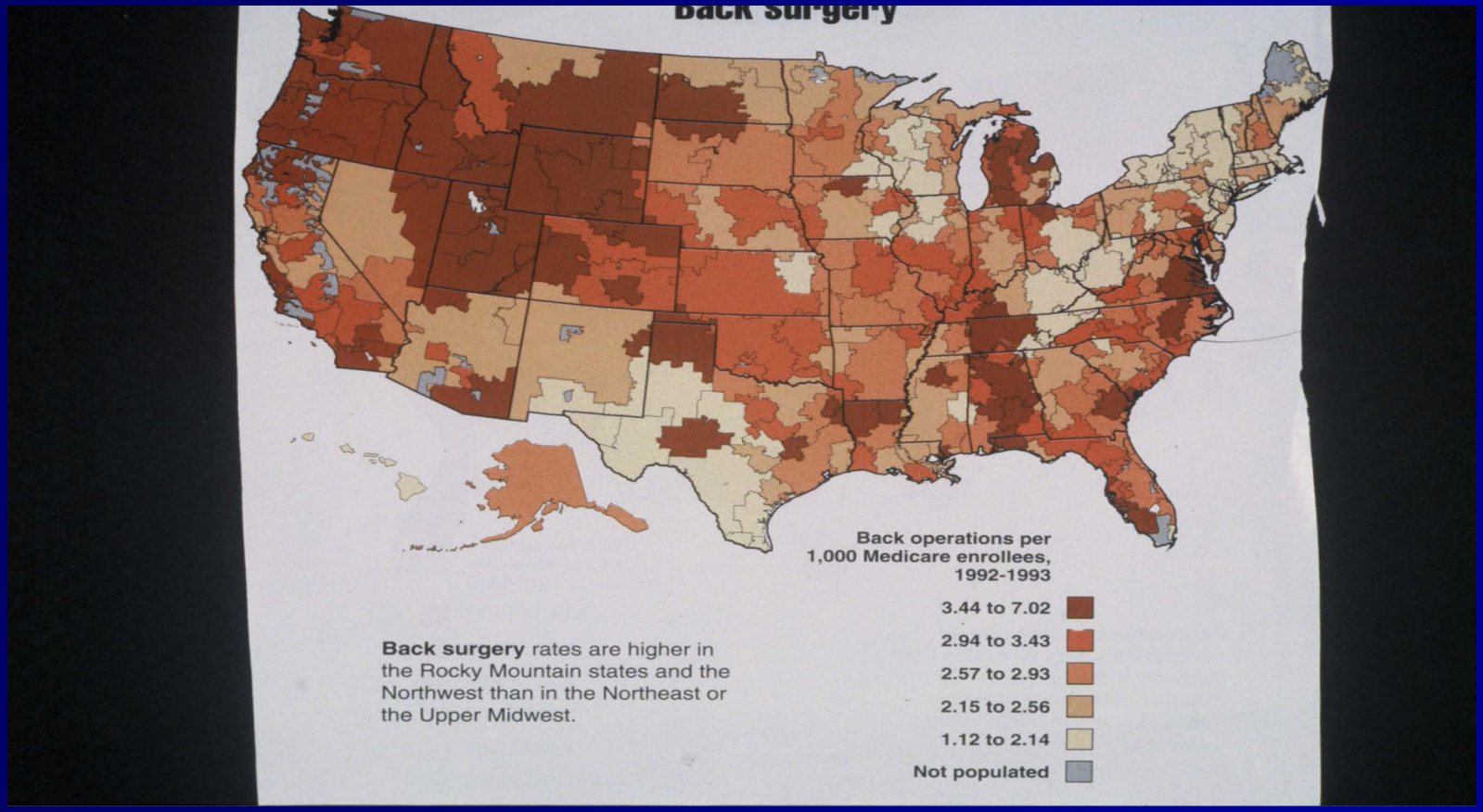
references

- Magladery, J & McDougal, D: Electrophysiological studies of nerve and reflex activity in normal man: Identification of certain reflexes in electromyogram and nerve conduction velocity of peripheral nerves. 1950. Johns Hopkins Hospital Bull.86:265.
- Johnson, E, Radecki, P & Paulson, G: Huntington Disease: early identification by H reflex testing. 1977. Arch PM&R. 58:162

references

- Ishikawa, et al: Low frequency depression of H reflex in normal and spinal man.1966 Exp Neurol. 15:140
- Hohmann, T & Goodgold, J: Study of abnormal reflex in spasticity. 1961. 40:52
- Teasdall,R et al: Electrophysiologic studies of reflex activity in patients with lesions of CNS. 1952 Bull Johns Hopkins Hosp. 91:267

Back surgery



Discetomy

W JOHNSON

ed

THANK YOU

Questions ????