

## ***Evaluation of posterior tibial H/M ratio in cerebrovascular accidents***

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### **Abstract**

**Introduction:** Clinical use of the late responses during routine neurophysiological examination has significantly increased the diagnostic yield of the neurophysiological evaluation. The H max to M max ratio (H/M ratio) is considered a suitable index for illustrating the level of reflex excitability of the motor pool.

**Methods:** In this study posterior tibial nerve H/M ratio changes in cerebrovascular accidents (CVA) evaluated. This investigation was carried out in 22 normal subjects aged 40-65 years with mean 52 years, and in 40 patients with CVA aged 42-63 years with mean 57 years.

**Results:** In normal subjects no significant differences were found between the mean values observed between right and left sides. In patients significant increased H/M ratios in both sides with more in non-plegic leg ( $P<0.01$ ) were found. The facilitation of Babinsky sign in patients is significantly associated with low H/M ratios ( $P=0.003$ ). The H/M ratio changes were not significantly associated with severity of hemiplegia ( $P=0.3$  for lower extremities,  $P=0.9$  for upper extremities). The H/M ratio was increased in ischemic lesions ( $P<0.01$ ), but in intracerebral hemorrhages the soleus H/M ratio increases in non-plegic side the same as the plegic side.

**Conclusion:** The posterior tibial nerve H/M ratios are increased in CVA bilaterally due to decreased presynaptic inhibition Ia terminals, thus amplitude of H reflexes increased without increased amplitude of M response.

**Keywords:** H/M ratio, posterior tibial nerve, H reflex, CVA, soleus, cerebrovascular accidents, ischemic, hemorrhage, Babinsky sign's.

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## Introduction

Many spinal pathways control the excitability of the stretch reflex and a malfunction in any one of them could theoretically produce an exaggeration of the stretch reflex. The underlying mechanisms are probably the presynaptic inhibition.<sup>(8)</sup>

In 1918, Hoffmann showed that submaximal stimulation of mixed motor-sensory nerves, insufficient to produce a direct motor response, produces a muscle contraction after a latency that is much longer than that of the direct motor response.<sup>(9)</sup> Clinical use of the late responses during routine neurophysiological examination has significantly increased the diagnostic yield of the neurophysiological evaluation.<sup>(11)</sup>

The H max to M max ratio (H/M ratio) is considered a suitable index for illustrating the level of reflex excitability of the motor pool, which in turn is dependent on the facilitation of the transmission between the IA fiber and the  $\alpha$ -motor neuron.<sup>(3-5-15)</sup>

Decreased presynaptic inhibition of IA terminals might cause exaggeration of the stretch reflex, as has been argued that, in normal subjects under resting condition<sup>(6)</sup>, but decreased immediately after fatigue.<sup>(7)</sup>

Electrical stimulation of the posterior tibial nerve in the popliteal fossa at various intensities evokes two electromyographic responses in soleus muscle. Whereas the M wave due to

direct activation of the axons of the soleus  $\alpha$ -motor neuron pool, the H wave is the reflex discharge of the same pool in response to the orthodromic afferent volley traveling in the large-diameter Ia fibers originating in the muscle spindles the maximal H reflex is elicited by submaximal nerve stimulation and is mainly due to the activation of the slow-twitch motor units. The maximal M wave is elicited by supramaximal nerve stimulation and is the electrical counterpart of the activation of all motor units of the pool, indicating the fast-twitch units.<sup>(2-1-5-14)</sup>

After central nervous system injury, the inhibition of cortex on stretch reflexes diminishes or disappears. One of the thesis is primary axonal degeneration with secondary segmental demyelination, involving predominantly proximal parts of the peripheral nerves, but we don't accept it because in acute phase, degeneration has not occurred.<sup>(12)</sup> The definite mechanism or mechanisms have not understood.

In this study posterior tibial nerve H/M ratio changes in cerebrovascular (CVA) accidents evaluated.

## Methods

This investigation was carried out in 22 normal subjects aged 40-65 years old with mean of 52, and in 40 patients with CVA aged 42-63 years old with mean of 57. All gave informed consent to the procedure. The patients had a unilateral focal lesion visualized on computed

tomography or MRI of brain. 20 of the lesions were in the area of the middle cerebral artery, 12 of the lesions were in the area of the anterior cerebral artery, 32 of patients suffered from ischemia and 8 patients had intracerebral hemorrhage.

At the time of the investigation, the duration of the illness varied from 3 to 7 days (acute phase of CVA).

#### *Clinical examination:*

For all of the patients clinical examinations have been done, including grading of force in plegic extremities for lower and upper extremities (0-5 method).

#### *Babinsky sign's:*

Facilitation of Babinsky sign's was classified in three grades, grade 0 is without response of flexion or extension of toe or fingers in plegic side, but flexion in non-plegic side was seen, grade 1 is facilitation with severe or repeated stimulation, and grade 2 was easily facilitated with one stimulation .

#### *General experimental arrangement:*

The subjects were seated comfortably in a dental chair. The leg that was to be examined was fixed loosely with the hip semi flexed, knee slightly flexed.

#### *H reflexes:*

Nerve conduction velocity of posterior

tibial nerve has been done. The H reflexes elicited in the soleus muscles. The surface EMG was recorded from pairs of non-polarizable disks (0.9 cm diameter) placed 1.5 cm apart over the belly of soleus muscle. Percutaneous electrical stimulation was applied to the posterior tibial nerve through bipolar electrodes placed in the popliteal fossa.

Amplitudes of maximum H reflexes (peak to peak) were analyzed, and also the amplitudes of maximum M waves (peak to peak) were analyzed.

#### *Excluded criteria's:*

These criteria were included:

- 1-the age above 65 years old.
- 2-Abnormal nerve conduction velocity of posterior tibial nerve.
- 3-Peripheral nerve diseases.
- 4-Other diseases of the central nervous system.

### **Results**

In normal subjects the posterior tibial nerve H/M ratios were assessed in 22 normal subjects. No statistical differences was found between the mean values observed between right and left sides, and the mean values of H/M ratio in 40 patients for soleus are shown in table 1 (increased H/M ratios in both sides with more in non-plegic leg) .

**Table 1: Distribution of findings in patients and normal subjects**

Subjects Findings	Hemiplegic side	Non-hemiplegic	Normal Right side	Normal Left side	Patient and normal
H latency	30.7+ 2.4	30.9+ 2.5	30.9+ 4.2	30.9+ 3.5	P=1
Mean of H/M ratio	0.327+ 0.103	0.385+ 0.127	0.235+ 0.108	0.255+ 0.127	P<0.01
Age	57+ 5	57+ 5	52+ 5	52+ 5	P=0.20
Sex M/F	23/17	23/17	17/5	17/5	P=0.16
Number	40	40	22	22	-----

The facilitation of Babinsky sign's in patients has significant differences with lower H/M ratios ( $P=0.003$ ), the H/M ratios were increased in easily facilitated Babinsky sign's which are shown in table 2.

The H/M ratios had no significant

differences in relation to severity of hemiplegia ( $P=0.3$  for lower extremities,  $P=0.9$  for upper extremities), table 3 shows force of hemiplegic lower extremities and H/M ratios.

**Table 2: H/M ratios in patients to facilitation rate of Babinsky sign's**

H/M ratio Babinsky	0.1	0.2	0.3	0.4	0.5	Total
0	1	0	0	5	0	9
1	0	2	10	7	0	20
2	2	2	3	1	3	11
-----	3	4	16	13	4	40

The H/M ratios in relation to site of lesions and kind of lesions (ischemic or

hemorrhagic) are shown in table 2.

**Table 3: Relation of force with H/M ratios in hemiplegic side of patients**

H/M ratio Force	0.1	0.2	0.3	0.4	0.5	Total
0/5	0	0	0	1	1	2
1/5	0	1	2	2	0	5
2/5	0	0	3	1	0	4
3/5	3	2	8	7	3	23
4/5	0	1	3	2	0	6
Total	3	4	16	13	4	40

$P=0.54$

**Table 4: Mean and SD of H/M ratios to site and kind of lesions**

H/M ratio Lesion	Num	Mean of H/M ratio in hemiplegic side	Mean of H/M ratio in non-hemiplegic	P value T test
MCA	21	0.309±0.1179	0.395±0.1499	P<0.05,T=2.0
ACA	11	0.354±0.0522	0.400±0.0775	P<0.20,T=1.5
Ischemic	32	0.325±0.1016	0.396±0.1282	P<0.01,T=2.5
ICH	8	0.337±0.1188	0.337±0.1188	P=1.00,T=0.0
Total	40	0.327±0.1037	0.385±0.1272	P<0.05,T=2.2

P=0.003

### Discussion

There was no asymmetry between the two sides in normal subjects. This finding is the same as other findings in humans, <sup>(4)</sup> but in a study on rats, asymmetry was reported. <sup>(6)</sup> In the population of hemiplegic patients, the soleus H/M ratio were increased on both sides (P<0.01), but it increased more on the non-hemiplegic side (P<0.05). These findings different from other investigations, <sup>(4)</sup> may be because this study was done in acute phase of CVA. In this phase the patients had no spasticity (in this phase hypotonia and hyporeflexia often are present). In this study increase of H/M ratios were seen, in ischemic lesions, the soleus H/M ratio increased more in non-plegic side, but in intracerebral hemorrhage, the soleus H/M ratio in non-plegic side increased the same as the plegic side, and we can't describe this finding and it must be to evaluated more .

In normal condition the primary afferent depolarization, interneuron's are tonically under control of the cortex. Loss of this control after a corticospinal lesion would be expected to produce a decrease in the presynaptic inhibition Ia terminals, <sup>(3)</sup>

thus amplitude of H reflexes are increased, but M responses are not under control of cortex and then H/M ratios are increased bilaterally <sup>(10)</sup> with prominency on the non-hemiplegic side. H reflex is sensitive to presynaptic inhibition of Ia afferent than the stretch reflex and tendon jerk. In this study there were no spasticity and heightened tendon jerk, especially the H/M ratio increased bilaterally. We think that H/M ratio or H reflex amplitude increases are due to loss of inhibition by cortex, and has no relation with spasticity or tendon jerk, but both spasticity and H/M ratio are under control of cortex. In this study those patients that Babinsky sign's is early facilitate (number 2), H/M ratio is smaller than the patients with number 1. This hypothesis is the same as other reports (Morita et al 1997-Nakashima et al 1989). <sup>(13-12)</sup>

### Conclusion

The posterior tibial nerve H/M ratios are increased in CVA bilaterally due to decreased presynaptic inhibition Ia terminals, thus amplitude of H reflexes increase without increased amplitude of M response.

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## بررسی H/M ratio عصب تی بیال خلفی در سکته های مغزی

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### چکیده

**زمینه و هدف:** استفاده بالینی از واکنشهای تاخیری در بررسی های نوروفیزیولوژیک روزبه روز افزایش یافته است. نسبت حداکثر رفلکس H به حداکثر موج M یک شاخص مناسب برای نشان دادن سطح تحریک پذیری حرکتی این رفلکس است. در این مطالعه H/M ratio عصب تی بیال خلفی در بیماران دچار حوادث عروقی مغز بررسی شد.

**روش بررسی:** در این مطالعه H/M ratio ۲۲ فرد سالم که از نظر سنی مشابه بیماران بودند با ۴۰ بیمار دچار سکته حاد مغزی مقایسه شد.

**یافته ها:** در افراد سالم H/M ratio دو اندام اختلاف معنی دار نداشت. در بیماران H/M ratio هر دو اندام (فلج و غیر فلج) افزایش داشت ( $P < 0.01$ )، که در طرف غیر فلج این اختلاف بیشتر بود. تسهیل علامت بابنسکی در بیماران بطور مشخص همراه پائین بودن H/M ratio است ( $P = 0.003$ ). میزان تغییرات H/M ratio با شدت فلج رابطه معنی دار ندارد (در اندامهای تحتانی  $P = 0.3$  و در اندامهای فوقانی  $P = 0.9$ ). در ضایعات ایسکمیک H/M ratio افزایش یافته ( $P = 0.01$ ) که در اندام غیر فلج بیشتر است، ولی در ضایعات خونریزی داخل مغزی افزایش دو طرفه تقریباً مساوی است.

**نتیجه گیری:** H/M ratio عصب تی بیال خلفی در هر دو اندام تحتانی بیماران دچار سکته مغزی افزایش می یابد که ناشی از کاهش مهار سیناپتیک پایانه های عصبی Ia است. این افزایش ناشی از افزایش دامنه رفلکس H است. **واژه گان کلیدی:** H/M ratio، عصب تی بیال خلفی، رفلکس H، سکته مغزی، حوادث عروقی مغزی ایسکمیک، حوادث عروقی مغزی خونریزی، علامت بابنسکی.