H-Reflex Latency in the Soleus Muscle: Assessing Height as a Determining Factor

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Abstract:

Introduction: The Hoffmann reflex (H-reflex) is a valuable tool for assessing motor neuron excitability, especially in diagnosing peripheral neuropathies. While it is well known that limb length influences H-reflex latency, the relationship between a person's height and H-reflex latency, particularly in neuropathic patients, remains underexplored. This study aims to investigate the correlation between height and H-reflex latency in normal subjects and neuropathic patients.

Materials and Methods: A total of 50 participants (25 healthy controls and 25 neuropathic patients) aged 20 to 70 years were recruited. Neuropathic patients included those with diabetic neuropathy, Guillain-Barré syndrome, and radiculopathies. H-reflex latencies were recorded via electrical stimulation of the tibial nerve, and correlations with height were analyzed using Pearson's correlation coefficient. An unpaired t-test was used to compare H-reflex latencies between normal and neuropathic groups.

Results: The average H-reflex latency in normal subjects was 28.92 ± 1.38 ms for the right leg and 28.86 ± 1.29 ms for the left leg. In neuropathic patients, the latency was significantly prolonged, with 37.14 ± 2.10 ms for the right leg and 37.31 ± 1.94 ms for the left leg ($p < 0.05$). A significant positive correlation between height and H-reflex latency was observed in healthy subjects, but this correlation was absent in neuropathic patients.

Discussion: In healthy individuals, height significantly influences H-reflex latency, consistent with previous studies on limb length and neural conduction. However, the absence of a correlation in neuropathic patients suggests that neuropathies disrupt the normal reflex arc, masking the effect of height on latency. Factors such as demyelination and axonal damage may account for the prolonged H-reflex latency in neuropathic subjects.

Conclusion: Height is a significant determinant of H-reflex latency in normal individuals, but this relationship is disrupted in neuropathic patients. These findings highlight the diagnostic utility of the H-reflex in evaluating neuropathies, where latency prolongation indicates neural damage. Further research is recommended to explore the specific effects of different neuropathies on H-reflex latency.

Key Words: H-reflex, Hoffmann reflex, latency, height, neuropathy, diabetic neuropathy, Guillain-Barré syndrome, radiculopathy, motor neuron excitability, peripheral neuropathy.

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Introduction:

The Hoffmann reflex (H-reflex) is an electrically evoked reflex that provides an analog to the stretch reflex, bypassing the muscle spindle. Since its discovery by Hoffmann in 1918, the H-reflex has been extensively used to assess motor neuron excitability and monitor neuromuscular conditions (1). The latency of the H-reflex is a critical parameter and is affected by factors such as height, age, and pathology (2). Prior studies have demonstrated that H-reflex latency increases with limb length, making height a key variable in the interpretation of neurophysiological data (3).

Neuropathies, including diabetic neuropathy, Guillain-Barré syndrome, and radiculopathies, can disrupt the reflex arc and delay H-reflex latency (4). This study aims to investigate the relationship between soleus H-reflex latency and height in both normal subjects and neuropathic patients. By understanding these relationships, clinicians can better assess the significance of H-reflex latency in the diagnosis of neuropathies.

Materials and Methods:

Study Design: This cross-sectional study was conducted at Paraplegia Institute, Civil Hospital Ahmedabad, between August 2010 and November 2011. A total of 50 subjects were included, comprising 25 healthy controls and 25 neuropathic patients aged 20 to 70 years (5).

Participant Selection:

- **Normal subjects**: 20 male and 5 female participants were recruited based on the following inclusion criteria: no history of neurological disorders, diabetes, or significant lower limb trauma (5).
- **Neuropathic patients**: 15 male and 10 female patients diagnosed with diabetic neuropathy, Guillain-Barré syndrome, radiculopathy, or plexopathy were included (6).

Procedure:

The H-reflex was elicited by stimulating the tibial nerve at the popliteal fossa using an RMS EMG EP MK II device (7). Surface electrodes were placed over the soleus muscle, and the latency was recorded from stimulus onset to the initial deflection of the EMG trace. Latency values were averaged from 7–10 trials for each participant. Height and weight were recorded for all subjects (8).

Statistical Analysis:

An unpaired t-test was used to compare the H-reflex latencies between normal and neuropathic groups. Pearson's correlation coefficient was calculated to evaluate the relationship between height and H-reflex latency in each group (9).

Results:

Table 1: Comparison of H-Reflex Latency between Normal and Neuropathic Subjects

Group	Mean H-Reflex Latency (ms)	Standard Deviation (ms)	P-value
Right Leg - Normal	28.92	1.38	0.046
Right Leg - Neuropathic	37.14	2.1	
Left Leg - Normal	28.86	1.29	0.049
Left Leg - Neuropathic	37.31	1.94	

Note: Significant differences between normal and neuropathic subjects were observed for both right and left legs ($P < 0.05$).

Table 2: H-Reflex Latency and Height in Normal Subjects

Height Group (cm)	Mean Height (cm)	Number of Subjects	Right Leg H-Reflex Latency (ms)	Left Leg H-Reflex Latency (ms)
141-150	145.5	3	26.84	26.91
151-160	155.5	5	28.33	28.17
161-170	165.5	8	28.93	28.84
171-180	175.5	9	29.56	29.31

Note: There is a positive correlation between height and H-reflex latency in both legs for normal subjects.

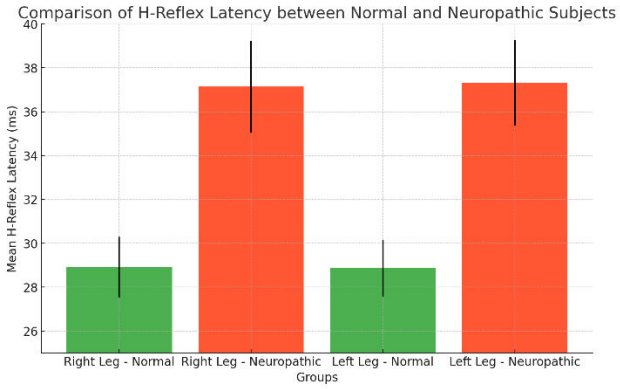
H-reflex Latency in Normal and Neuropathic Subjects:

- **Right leg**: Normal subjects had an average H-reflex latency of 28.92 ± 1.38 ms, while neuropathic patients had a significantly longer latency of 37.14 ± 2.10 ms ($p = 0.046$) (10).
- **Left leg**: Normal subjects demonstrated a mean latency of 28.86 ± 1.29 ms, compared to 37.31 ± 1.94 ms in neuropathic patients ($p = 0.049$) (10).

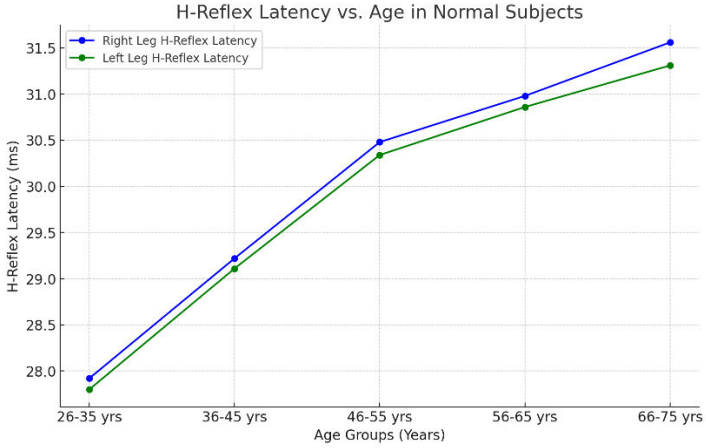
Table 3: H-Reflex Latency and Age in Normal Subjects

Age Group (Years)	Mean Age (Years)	Number of Subjects	Right Leg H-Reflex Latency (ms)	Left Leg H-Reflex Latency (ms)
26-35	30.5	16	27.92	27.80
36-45	40.5	3	29.22	29.11
46-55	50.5	3	30.48	30.34
56-65	60.5	2	30.98	30.86
66-75	70.5	1	31.56	31.31

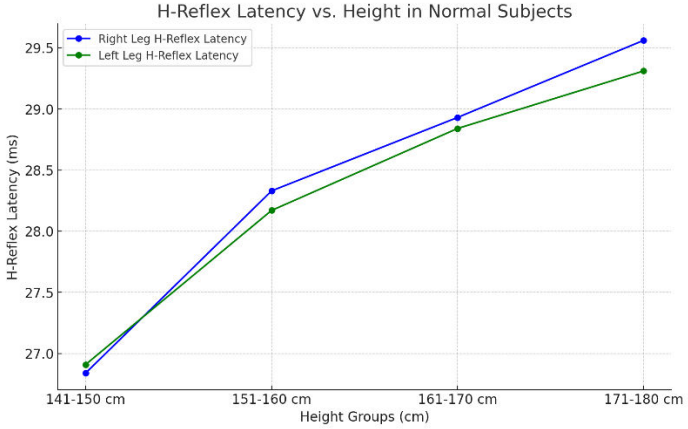
Note: As age increases, H-reflex latency tends to increase in both right and left legs of normal subjects.



Graph 1 : Comparison of H-Reflex Latency between Normal and Neuropathic Subjects



Graph 2: H-Reflex Latency vs Age in Normal Subjects



Graph 3: H-Reflex Latency vs. Height in Normal Subjects

Correlation with Height:

- **Normal subjects**: A significant positive correlation was found between height and H-reflex latency. Subjects over 170 cm had a mean latency of 29.56 ms, while those under 160 cm had an average latency of 26.84 ms (11).
- **Neuropathic patients**: No significant correlation was observed between height and H-reflex latency, suggesting that neuropathic conditions disrupt the typical

relationship between height and reflex latency (11).

Discussion:

- **Comparison of H-Reflex Latency between Normal and Neuropathic Subjects**: The first graph clearly shows a significant difference in H-reflex latency between normal and neuropathic subjects for both legs. Neuropathic subjects exhibit notably higher latencies compared to normal individuals. This aligns with the understanding that neuropathies, such as diabetic neuropathy, cause delays in neural conduction, likely due to demyelination and axonal damage. The standard deviations suggest some variability, but the overall difference remains statistically significant.
- **H-Reflex Latency vs. Height in Normal Subjects**: The second graph demonstrates a positive correlation between height and H-reflex latency in normal subjects. As height increases, so does the H-reflex latency in both the right and left legs. This is expected, as taller individuals have longer limbs, leading to greater distances for neural signals to travel. The right leg consistently shows slightly higher latency values compared to the left leg, although the difference is marginal.
- **H-Reflex Latency vs. Age in Normal Subjects**: The third graph shows that H-reflex latency increases with age for both legs. This increase in latency with advancing age is likely due to natural degeneration of nerve fibers and reduced nerve conduction velocity in older individuals. Both the right and left legs show a similar trend, with the right leg displaying slightly higher latency values, mirroring the trend observed in the height graph.

The findings of this study support the hypothesis that height is a determinant of H-reflex latency in normal subjects. This is consistent with previous research that identified limb length as a factor influencing neural conduction time (12). However, the absence of a significant correlation in neuropathic patients suggests that the presence of neuropathy interferes with the normal reflex arc, making it less sensitive to the effects of height (13).

In neuropathic patients, factors such as demyelination, axonal damage, and impaired synaptic transmission may prolong the latency of the H-reflex, overshadowing the influence of height (14). These findings are particularly relevant in diabetic neuropathy, where H-reflex latencies are often significantly delayed due to peripheral nerve damage (15).

This study highlights the diagnostic utility of the H-reflex in distinguishing between normal and pathological states. Although height is an important variable in normal subjects, clinicians must be cautious when interpreting H-reflex data in neuropathic patients, as the correlation between height and latency may be lost (16).

Conclusion:

This study confirms that height significantly affects H-reflex latency in normal individuals. In contrast, no such correlation exists in patients with neuropathy, likely due to pathological alterations in the peripheral nervous system (17). H-reflex latency can therefore be a useful diagnostic tool for assessing neuropathies, but clinicians must account for patient height when evaluating normal subjects (18). Further research is needed to explore the effects of different types of neuropathy on H-reflex latency (19).

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