Evaluation of the relation between triceps surae H-reflex, M-response latencies and thigh length in normal population

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Background: The H-reflex is a useful electrophysiological procedure for evaluating the status of the peripheral nervous system, especially at the proximal segment of the peripheral nerve. The purpose of this study is to investigate the relation between triceps surae H-reflex and M- response latencies and thigh length in normal population, in order to determine if there is any regression equation between them. **Materials and Methods:** After screening 75 volunteers by considering inclusion and exclusion criteria, 72 of them were selected to enroll into our study (34 men and 38 women with the mean age of 36.04 ± 7.7 years). In all of the subjects H-reflex and M-response latencies were recorded by standard electrophysiological techniques and thigh length was measured. Finally, our data was analyzed for its relations with respect to ages in both sexes by appropriate statistical and mathematical methods. **Results:** Mean ± SD for H-reflex latency was 27.94 ± 1.6 ms. We found a significant correlation between H-reflex latency and M-latency (r = 0.28), no significant correlation was found between H-reflex latency and thigh length (r = -0.051). Finally based on our findings we introduce a new formula in this paper. **Conclusion:** We found a significant correlation among of M-response latency and other variables (H-reflex latency and thigh length). Despite this it was eliminated from our formula. The relationship between H-reflex latency and age was significant. Further studies are required to delineate the clinical usage and interpretation of the formula, which we found in this study.

Key words: Aging, H-reflex, M-response, thigh length

INTRODUCTION

The H-reflex was first described by Hoffman in 1918.[1] The H-reflex is believed to be a CMAP (Compound Muscle Action Potential) arising from an electrical afferent activation of a monosynaptic reflex arc.[1,2] The H-reflex is a useful electrophysiological procedure for evaluating the nerve conduction through the entire length of the afferent and efferent pathways, especially at the proximal segment of the peripheral nerve, which is inaccessible by routine surface stimulating and recording techniques,[3] and also suitable for evaluation of the potential entrapment of the S1 nerve root,[4-6] hence, it is sensitive in detecting mild S1 radiculopathy.[7] In studying S1 radiculopathy, prolonged onset latency and/or absence of the H-reflex on the affected side are the most commonly used measures of the H-reflex.[8-10] The H-reflex amplitude, in contrast, has been given limited attention as a diagnostic parameter of S1 radiculopathy because of its wide variability between subjects even if the intensity of the electrical stimulation is held constant.[11,12] H-reflex is found to correlate highly with both age and leg length. The techniques of Braddom and Johnson are suggested as they represent nomogram and regression equation for obtaining individual optimal H-reflex latencies.[13,14] Normal values for the tibial H-reflex latency in adults range from 27 to 35 ms with side-to-side differences of, 1.2 ms or, 1.4 ms in younger adults and, 1.8 ms in elderly.[11,14,15]

Calculation of optimal H-reflex latency with available formula and nomograms is time-consuming and impractical for using routinely. According to the importance of H-reflex latency in the diagnosis of S1 radiculopathy; we decided to find a more practical formula to measure of H-reflex latency. So we investigated the relation between triceps surae H-reflex and M- response latencies and thigh length in normal population (also we evaluated effects of subject's age and sexes on H-reflex and M-response latencies), in order to determine if there is any regression equation. The result of our research has been presented as an equation, in the hope that it may be useful in clinical practice. This relationship has not been thoroughly tested before.

MATERIALS AND METHODS

Participants

This is a cross sectional study that performed at period of May to December 2011. Samples is selected with conventional method from patients referred to the electrodiagnostic clinics of physical medicine and

rehabilitation department, faculty of medicine, Isfahan, Iran. Seventy-five healthy subjects (35 men, and 40 women) participated in this study with an age range of 20-53 years. All participants were informed about the tests, and the study was approved by the Ethical Committee of Isfahan University of Medical Sciences (IUMS).

They underwent a complete medical examination by authors of study, and only individuals free from muscular, neurological, cardiovascular, metabolic and inflammatory diseases took part in the present investigation. The subjects with Body Mass Index (BMI) more than 30 excluded from our research because of likely error in thigh length measurement.

Method

The H-reflex was tested in room temperature with the subject lying prone, when the stresses on the spine are minimal and their skin warmed to 32°C, if cold.[16] All electrophysiologic tests were performed with Cadwell Sierra Wave equipment. Surface stimulating bar electrode with 0.5 cm in diameter and cathode-anode distance of 2 cm was applied longitudinally on the tibial nerve in the midline of the popliteal fossa with the cathode proximal to the anode to avoid anodal block. The active recording bar electrode was placed 15 cm distal to stimulating electrode, and the reference distally. As a ground, a metal electrode was applied between the stimulating and the recording electrodes on the skin of the calf. The electrodes were not removed until the whole experiment was completed to ensure exact placement and consistent results[17] [Figure 1]. Percutaneous direct rectangular current pulses with 1ms duration were delivered at a frequency of one pulse per 2-3 second to the tibial nerve to elicit the maximum H-reflex amplitude. The stimulating electrode placement was considered acceptable when the maximum H-reflex could be elicited with minimal M response. The H-reflex was recorded using a gain of 200-500 micro volt and filter of 10 Hz to 10 kHz band passes. Gain was not changed during the study. Subjects with a latency difference of more than 1.5 ms between left and right H-reflexes were excluded from the study. After obtaining H-reflex latency, we increased current intensity supramaximally for obtaining maximum M-response, after which its latency was recorded. In order to have less measurement errors, we considered the distance between greater trochanter and head of fibula as thigh length, in centimeters. This measurement was performed on both lower extremities.

Data analysis

The data analysis was performed by SPSS version 18 (SPSS Inc., Chicago, IL, USA). The critical level for statistical significance was set at 0.05. The data are presented as means ± Standard Deviation (S.D). Sex-related differences were analyzed with T-test. Pearson correlation was used to determine the degree
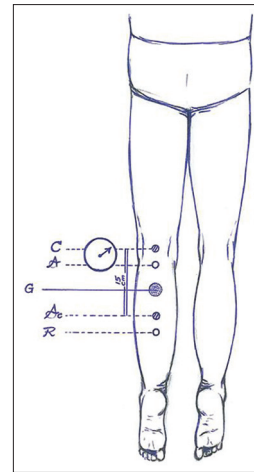
Figure 1: Location of stimulating and recording electrodes for the triceps surae H-reflex- C= cathode, A= anode, Ac= active, R=reference and G=ground electrodes

of association between variables. The multiple regression was used for obtaining the proposed relations.

RESULTS

Considering our inclusion criteria 75 subjects (35 men, and 40 women) participated in this study. Three cases were excluded after performing of nerve conduction study (two because of unobtainable H-reflex in one side and one because of side-to-side H-reflex latency difference of 1.9 msec). Thus, we completed the study with 72 healthy subjects, 34 men (47.2%) and 38 women (52.8%). The subjects' mean age was 36.04 ± 7.7 years with a range of 20- 53 years. The subjects' mean thigh length was 42.3 ± 1.7 cm with a range of 38.5- 46 cm. Mean H-reflex latency was 27.94 ± 1.6 msec with a range 24.4-31.8 msec. A significant correlation between age and H-reflex latency was present. All correlation coefficients are shown in Table 1. There was no significant correlation between thigh length and H-reflex latency.

The mean M-response latency was 4.17 ± 0.63 msec with range of 3-6 msec. There was significant correlation between M-response latency and age. On the other hand, according to the Pearson correlation test between M-response latency and thigh length, a significant correlation was present. Finally, there was significant correlation between M-response latency and H-reflex latency.

T-test results for significant difference between men and women in tested variables are shown in Table 2. As can be seen, H-latency and thigh length have statistically significant difference between men and women. There was no significant difference between right and left sides in all tested variables.

Since we were interested to predict the H-reflex latency, we investigated the relationship between all measured variables

and H-latency. Results of our equation's coefficients for M-response latency, H-reflex latency, age, thigh length, and sex are shown in Table 3. We could not find any statistically significant association, based on regression analysis, between H-reflex latency and thigh length and M-response latency. But there regression analysis showed significant relationship between other variables (age, sex and thigh length). Finally, we found the following formulae, for prediction of the latency of H-reflex:

H latency =34.48+ (age ×0.13) – (thigh length ×0.276) + (0.96; if male)

DISCUSSION

H-reflex is a beneficial tool for clinical use as mentioned in literatures. Therefore, review of factors that affecting it is very important. In this paper we described a method to predict the H-latency.

We found a significant direct correlation between H-latency and age, which was in agreement with previous reports.[13,14,18,19] However, previous studies examined the effect of age on other H-reflex parameters. Ghavanini and Sadeghi found no significant correlation between age

Table 1: Pearson correlation coefficients between different variables

		thigh. lengh	age	H.latency	M.latency
thigh. lengh	Pearson Correlation	1	0.149	-0.051	0.255**
age	Pearson Correlation	0.149	1	0.612**	0.280**
H.latency	Pearson Correlation	-0.051	0.612**	1	0.178*
M.latency	Pearson Correlation	0.255**	0.280**	0.178*	1

**Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 2: T-test analysis for difference of variable means among men and women

Variable	Mean±SD for men	Mean±SD for women	P value
Thigh. length	43.3±1.2	41.5±1.7	0.000*
Age	37.2±7.5	34.99±7.92	0.087
H. latency	28.34±1.63	27.58±1.6	0.006*
M. latency	4.27±0.79	4.08±0.43	0.075

*Difference is significant between men and women at the level of 0.05

Table 3: Regression coefficients for prediction of H-reflex latency (B column)

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	34.480	2.848		12.106	0.000
	sex	0.960	0.241	0.291	3.987	0.000
	thigh length	-0.276	0.069	-0.293	-4.022	0.000
	age	0.130	0.013	0.614	9.726	0.000

a. Dependent Variable: H latency

and central loop of the gastrocnemius-soleus H-Reflex latency,[5,20] but Wang *et al.*, found a direct correlation between them.[21] Multiple studies demonstrated effect of age on H-reflex amplitude in different positions.[22-24] Bour *et al.*, described that H/M ratios decreased with increasing age.[25] Therefore, the H-reflex latency would be expected to proportionally prolong in elderly patient because of its pathway seems to be affected by several age-related changes, involving both interneurons and the afferent and efferent tracks.[26]

Furthermore, we found a significant relationship between M-response latency and other tested variables (age, H-latency and thigh length). Authors of this manuscript found only one study that is reporting M-response latency.[18] Scaglioni *et al.*,, studied 11 young and 10 elderly healthy subjects and described the effect of age on H-reflex and M-response latencies, but they did not investigate the relation of M-wave and H-reflex. However, they found no significant correlation between age and M-response latency. So to the knowledge of the authors, there was no published study about the relation between H-latency and M-latency.

Interestingly, despite the significant correlation of M-response latency with other variables, it was eliminated from our formula. Statistically, this could be attributed to the fact that the other variables are better predictors for H-latency variation than M-latency. However, more studies are needed to understand the effects of M-latency on the H-latency.

As mentioned there was no significant correlation between individual thigh length and H-latency (indirect weak correlation, R = - 0.051). We did not find any published article regarding the correlation between H-latency and thigh length, but in many studies leg length and height had significant relation with H-latency.[13,14,18,19,27,28] Based on anatomical pathway of H-reflex loop, the weak indirect correlation between thigh length and H-latency is in contrary with what we expected previously (we expected a positive correction constant in the formulae). This discrepancy may be due to methodological designs. Even though we considered BMI, the circumference of participant's thigh was not measured. In addition, the effect of thigh length in our formula (its negative coefficient) can be because of statistical calculations, which clinically are of least importance or it may be due to narrow ranges of it (42.3 ± 1.7 cm) compared to wider ranges of age (36.04 ± 7.7 years) which has a strong effect in our formula. However, no clear clinical explanation found for this finding, and further investigations are required to understand the results.

In this study, the impact of sex on estimation of optimal H-latency was formulated by including a constant

coefficient of 0.96 for men to the final equation. This can be reasonable because of statistically significant longer thigh length in the males of our studied subjects.

Moreover, we found no significant difference between right and left sides in all tested variables which is consistent with Ginanneschi *et al.,,* study.[29]

Also, we investigated two other subject matters. First, "adjusted R square" is estimated around 0.45, which indicates the variables chosen for estimation of H-latency (i.e. age, sex and thigh length) are only 45% effective on its variation [Table 3]. Therefore, other factors can also be decisive on H-reflex parameters that should be considered, such as leg length[13,14] subject's position when testing in standing or sitting or lying or angle of knee flexion,[30-34] subject be in complete muscle relaxation and free of anxiety,[35] person voluntary muscle contractions,[36] effects of tooth clench[37] and Jendrassik maneuver[38] on H-reflex parameters, frequency and intensity of stimulations,[39] antagonist muscle stimulation,[40] etc. The second matter is age of participants that is the most influential parameter among other variables studied in this research for estimation of H-latency. This was found in line with other previous studies as noted above.

CONCLUSION

The purpose of this study was evaluation of the relation between triceps surae H-reflex, M- response latencies and thigh length in healthy subjects, among which the thigh length was investigated for first the time. We found that M-response latency had significant correlation with all tested variables and age had better predictive value than other tested variables for estimation of H-reflex latency. Furthermore, the clinical usage and interpretation of the formula, which we found in this study should be investigated by more researches, preferably on normative data with larger numbers of subjects and of course by considering other factors, which influence the H-reflex parameters.

ACKNOWLEDGMENTS

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