Original Article

Evaluation of Relationship between Extensor Digitorum Communis Hoffmann-reflex Latency and Upper Limb Length and Age

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Abstract

Background: The aim of this study was to evaluate the relation between normal values of extensor digitorum communis (EDC) Hoffmann-reflex (H-reflex) latency, upper limb length and age in normal participants, and to determine whether there is any regression equation between them. **Materials and Methods:** In this cross-sectional study, 120 upper limbs of 76 normal volunteers (55 limbs of 34 men and 65 limbs of 42 women) were participated in this study. The onset latency of EDC H-reflex was determined with standard electrodiagnostic techniques and was recorded. **Results:** The mean EDC H-reflex latency was 15.89 ± 1.41 ms. There was a positive significant correlation between EDC H-reflex latency and upper limb length ($r = 0.749$, $P < 0.0001$) and also arm length ($r = 0.758$, $P < 0.0001$), but there was a nonsignificant indirect correlation between age and EDC H-reflex latency ($r = -0.111$, $P = 0.227$). The relation between H-reflex and sex was not statistically significant ($P = 0.46$). **Conclusion:** According to our result, there are good predictive values between upper limb length and arm length for the estimation of normal EDC H-reflex latency.

Keywords: *Arm length, extensor digitorum communis, Hoffmann-reflex, upper limb length*

Introduction

The Hoffmann-Reflex (H-reflex) derives its name from Hoffmann, who first in 1918 evoked this response.[1] The H response is a true reflex with a sensory afferent, synapse, and motor efferent segment. Involved circuitry of the H-reflex are included the Ia muscle spindles, alpha motor neurons and axons. The H-reflex in adults can routinely be elicited only by submaximal stimulating the tibial nerve in the popliteal fossa, recording the gastroc-soleus muscle. The H-reflex has been recorded from the femoral nerve (quadriceps muscle) and median nerve (flexor carpi radialis [FCR]) muscle that these recording have significant limitations.[2-6] H-reflex is a valuable electrodiagnostic technique for assessing nerve conduction through the entire length of afferent and efferent pathways, especially at proximal segment of peripheral nerve, and also for evaluating neurophysiological changes in compromised nerve roots.[7-9] Symmetrically absent H-reflexes are not abnormal, and H-reflex is often absent in otherwise normal individuals over the age of 60 years.[10,11] Prolonged-onset latency and/or absence of H-reflex on the affected side is the most common parameter of H-reflex used.[12-18] Many studies suggested that there is a strong correlation between H-reflex of lower limbs with both leg length and age. Furthermore, Braddom and Johnson[19,20] obtained a nomogram and regression equation for the evaluation of individual optimal soleus H-reflex latencies. Sometimes, especially in mild root involvement or cases with mainly sensory nerve root compromised, the only electrodiagnostic finding could be an abnormal H-reflex. Hence, regarding the feasibility of extensor digitorum communis (EDC) H-reflex latency in the diagnosis of C7–C8 radiculopathies and limited studies in this field, we decided to perform a study to investigate the relation between EDC H-reflex latency, upper limb length, arm length, and age in normal Iranian population. This study investigated five positions of wrist and hand in each person, to evaluate the possibility of facilitating factors in obtaining this reflex. In addition, we tried to find a practical formula for calculating and estimating optimal EDC H-reflex latency based on these parameters.

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Materials and Methods

Subjects

In this cross-sectional study that was done from November 2014 to April 2015 among upper limbs of healthy volunteers with aged between 20 and 60 years old. The volunteers and patients were selected according to the conventional method and were referred to academic electrodiagnostic centers. Furthermore, the procedures were explained for participants and have informed consent for participation to the study. Participants had neither symptoms nor signs of neurologic abnormalities of upper limbs in their history and physical examination. The participants with a history of hereditary polyneuropathies such as Charcot–Marie–Tooth, acquired polyneuropathies such as diabetic polyneuropathy, scar formation, or history of fracture in upper limbs were not meeting inclusion criteria. Furthermore, patients who not have continued study or have the sites of stimulation or recording were excluded from the study.

Techniques

The room and skin temperature for procedures was 25°C and 32°C–34°C, respectively, and also participants were in supine position.[21] The device for electrodiagnostic tests were Cadwell Sierra Wave electromyography machine. The diameter for surface stimulating bar electrode was 0.5 cm and also cathode-anode distance was 2 cm and was performed as longitudinally on the radial nerve, in the lower one-third of arm distal to spiral groove, between triceps and brachioradialis muscles. The place of surface E-1 electrode was over the belly of EDC muscle or proximal one-third of the dorsum of forearm as between ulna and radius bones, and the place of E-2 electrode was overinsertion of brachioradialis muscle at forearm region. The electrodes were performed until final of experiment as ensure exact placement and consistent results [Figure 1].[22] It is noteworthy a pulse with width of 0.5–1 ms and frequency of 2–3 s was delivered to radial nerve. The speed of instrument was 5 ms/div with the sensitivity of this was between 0.5 and 1 mV/div. Furthermore, onset latency of H-reflex was recorded from stimulus artifact to the first deflection. The placement of stimulating electrode was considered as no M-response, and H-reflex was increased the stimulus intensity with the replacement of an F-wave. Analyzing of H-response was done at least five positions of wrist and hand (active flexion, active extension, neutral, passive flexion, and passive extension). The length of upper limb was measured from C7 spinous process to tip of the third digit according to centimeters and the positions were as arm in 90° abduction, elbow in full extension, forearm in pronation, and digits in the extension. The length of arm was measured from C7 spinous process to tip of olecranon.

Analysis

Data were analyzed with SPSS software (version 16, SPSS Inc., Chicago, IL, USA). Independent *t*-test was used to access sex-related differences; the correlation test was performed with Pearson, and for obtaining proposed relations, Linear regression was performed. Furthermore, data showed in number or percent and mean ± standard deviation and $P < 0.05$ was considered as statistically significant threshold.

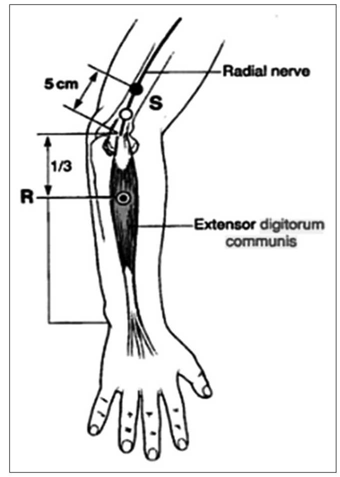

Figure 1: Schematic figure of electrode attachment; *S*: Stimulation site, *R*: Recording electrode

Results

In this study, of 120 participants, 55 (45.8%) were male and 65 (54.2%) were females with the mean of 36.8 ± 4.09 years. The measured parameters in participants are shown in Table 1. As shown, the mean of upper limb length and arm length were 87.1 and 45.07 cm, respectively. The mean of EDC H-reflex in studied participants was 15.89 ms. The comparison of different variables between studied males and females are shown in Table 2. As shown, the mean of upper limb and arm length in studied males were significantly more than females ($P < 0.0001$). Furthermore, the mean of EDC H-reflex in males was significantly more than females (16.71 vs. 15.19, respectively), but after the use of analysis of covariance while controlling for the effects of upper limb length and arm length, the relationship between EDC H-reflex and sex was not statistically significant ($P = 0.46$).

Pearson's correlation test showed there were positive significant correlation between EDC H-reflex with upper limb length ($r = 0.749$, $P < 0.0001$) and arm length ($r = 0.749$, $P < 0.0001$) [Table 3]; however, there was no significant correlation between EDC H-reflex and age (r = -0.111, $P = 0.227$).

As shown in Table 4, linear regression analysis of parameters affecting the H-reflex was done and four predictors, age, upper limb length, arm length and sex, retained in the final linear regression model. The results of this analysis, presented in Table 4, indicate that age (B = 0.072), upper limb length (B = 0.152), and arm length (B = 0.139) were significant parameters, but sex was not statistically significant (B = 0.239, $P = 0.293$).

Scatterplots of the relations between significant parameters, that is, age, arm length, upper limb length, with H-reflex are demonstrated in Figure 2.

As shown in Table 5, EDC H-reflex latency in different positions included neutral, active and passive flexion, and active and passive extension is similar, and there were no significant differences in the mean of EDC H-reflex latency in different positions ($P < 0.05$). Furthermore, using multiple linear regression analysis the following formulae was obtained: EDC H-reflex (ms) = −0.072 age (year) + 0.152 upper limb length (cm) + 0.139 arm length (cm).

Discussion

FCR H-reflex demonstrated in other studies that could be evaluate as complementary test for the diagnosis of some of upper limb pathologies in conventional conduction studies.[15-18] Khosrawi *et al*.[23] who investigated the relationship between FCR H-reflex and upper limb variables and age in the 69 normal participants, and the authors concluded that there was positive correlation between FCR H-reflex latency and upper limb length and also arm length; however, there was no significant correlation between FCR H-reflex latency and age. Furthermore, in this study, defined two formulae to predict optimal FCR H-reflex latency based on upper limb length and arm length:

- FCR H-reflex latency (ms) =0.23 × upper limb length (cm) – 4.3
- FCR H-reflex latency (ms) =0.32 × arm length (cm) + 1.1.

In our study, we proposed a formula to estimate EDC H-reflex latency based on age, upper limb length, and arm length. However, more studies are needed to determine the precision and clinical utility of this formula. In one study in 1995 by Jusić *et al*. 27 cases were examined and H-reflex of EDC muscle was achieved in 27% of cases.[24] Furthermore, Garcia *et al*. in 1979 described the technique of obtaining EDC H-reflex and showed that passive wrist extension can be facilitative in obtaining H-reflex of EDC muscle.[25] However, in this study, active extension and passive flexion of wrist and hand have more facilitating effect in obtaining EDC H-reflex compared with other positions. Based on pathophysiologic descriptions, H-reflex latency would be expected to proportionally prolong in elderly because of its pathway seems to be affected by several age-related changes, involving both interneurons and the afferent and efferent pathways.[4,10,26] However, the effect of age may be much less apparent on these parameters in participants under 60 years old as our participants were between 20 and 60 years old, and the age-related changes are more important in older participants. H-reflexes have a long pathway that may be influenced by multiple factors and length of the limb may have a significant influence on its latency.[5] Based on the anatomical pathway of H-reflex loop, this correlation between either thigh length and soleus H-reflex latency or upper limb length and EDC or FCR H-reflex latency are expectable. Several studies have investigated the relation between leg length, height, and soleus H-reflex latency and found significant correlation,[19,20,27,28] although a recent study did not find any relation between these two variables.[29] In this study, we found a significant correlation between EDC H-reflex

Table 1: Measured parameters of studied participants

Variables	Mean±SD
Upper limb length (cm)	87.1±4.09
Arm length (cm)	45.07±2.35
H-reflex (ms) EDC	15.89±1.41

Data are mean±SD. EDC: Extensor digitorum communis, SD: Standard deviation

Table 2: Comparison of different variables between studied males and females

Variables	Male	Female	P*
Age	38.78±9.46	35.17±10.36	0.05
Upper limb length (cm)	89.96±3.45	84.68±2.86	<0.0001
Arm length (cm)	46.73±2.16	43.67±1.41	<0.0001
EDC H-reflex (ms)	16.71±1.29	15.19±1.12	<0.0001
P (ANCOVA)†	0.46		

Data are mean±SD. *P* values calculated by *Independent sample *t*-test and †Analysis of covariance. EDC: Extensor digitorum communis, SD: Standard deviation

Table 3: Pearson's correlation coefficients of extensor digitorum communis H-reflex with different variables in studied population

Variables	Number of patients	Pearson correlation	P
Age	120	−0.111	0.227
Upper limb length	120	0.749	<0.0001
Arm length	120	0.758	<0.0001

Table 4: Linear regression analyses examining factors associated with extensor digitorum communis H-reflex among studied population

Factors*	Unstandardized coefficients B	Standardized coefficients Beta	P	95% CI for B	
				Lower bound	Upper bound
Age	−0.072	−0.129	0.034	−0.085	−0.001
Upper limb length	0.159	0.342	0.023	0.017	0.220
Arm length	0.139	0.387	0.011	0.053	0.413
Sex	−0.239	−0.085	0.293	−0.688	0.209

CI: Confidence interval

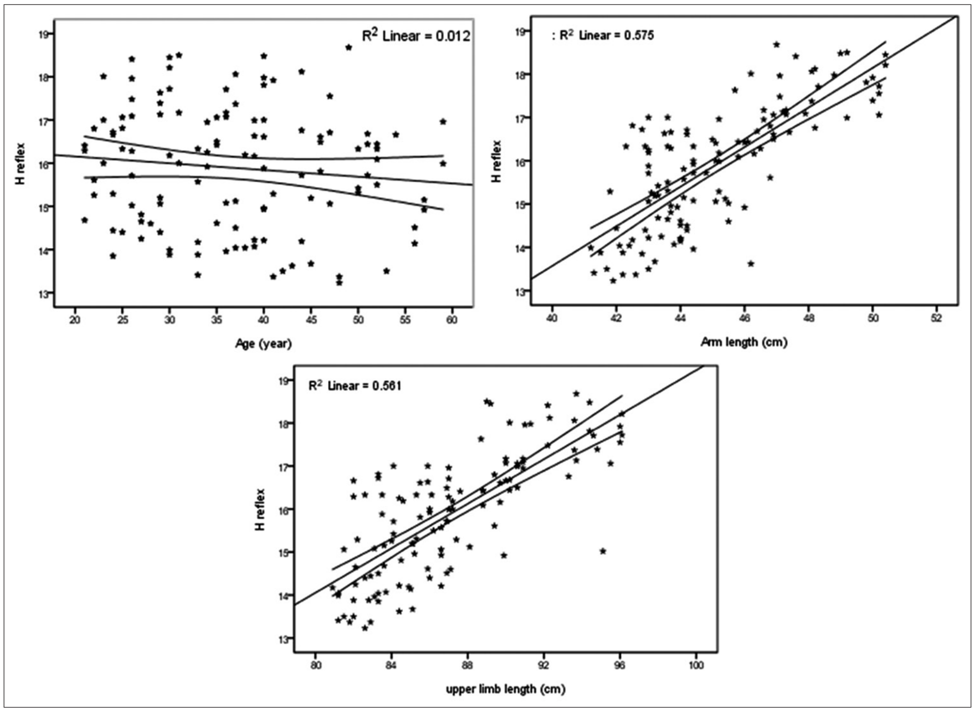

Figure 2: Scatterplots of the relations between age, arm length, upper limb length, and extensor digitorum communis Hoffmann-reflex (ms)

Table 5: Comparison of extensor digitorum communis H-reflex in different positions

Variables	Presence of signals				P*
	Positive		Negative		
	n	mean±SD	n	mean±SD	
Neutral	69	15.99±1.45	51	15.76±1.37	0.378
Active flexion	63	15.91±1.46	57	15.87±1.37	0.906
Passive flexion	86	15.84±1.43	34	16±1.41	0.601
Active extension	98	15.91±1.43	22	15.81±1.38	0.75
Passive extension	65	15.87±1.42	55	15.92±1.42	0.056

P-values calculated by *Independent sample *t*-test. SD: Standard deviation

latency and both upper limb length and arm length; however, more studies are needed to examine and compare the effects of these variables on the EDC H-reflex latency. As our results show, there are differences between EDC H-reflex latency as well as upper limb length and arm length among men and women. Thus, besides intrinsic differences between characteristics of nerve fibers and muscles of males and females, it may conclude that upper limb and arm lengths have had significant effects on EDC H-reflex latency. Of course, other parameters such as arm/forearm diameter may have important influences that could be evaluated in the future researches.

Conclusion

According to the abovementioned observations, the H-reflex recorded from EDC muscle – as H-reflexes recorded from soleus and FCR muscles – is significantly correlated with length of its pathway, but nonsignificantly with age. Furthermore, active extension and passive flexion of wrist and hand have more facilitating effect in obtaining EDC H-reflex compared with other positions. In final, we suggested examination of the intraclass reliability of the latency and amplitude of the H-reflex in the EDC (FCR) for the future studies.

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Conflicts of interest

There are no conflicts of interest.

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