ORIGINAL ARTICLE

Impact of age, height, weight and body mass index on sural sensory and soleus H-reflex study measures in healthy central Indian population

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ABSTRACT

Introduction: Sural sensory nerve conduction studies and Soleus H-reflex studies are affected earliest in systemic illness like diabetes mellitus. Age, sex, height and BMI are associated with nerve conduction study variables. Association of Soleus H-reflex study variables including H wave maximum amplitude and H/M ratio have been rarely explored yet. **Aims and objectives:** To evaluate the impact of anthropometric measures on sural sensory and soleus H-reflex study variables. **Design:** A cross sectional study. **Material and methods:** Fifty healthy participants (47 male and 3 female) with mean age 33.02 years and age range 21-60 years underwent electrophysiological evaluation (sural sensory and soleus H-reflex study). Sural SNAP amplitude, CV, H wave minimum latency, H wave maximum amplitude and H/M ratio values were obtained. **Results:** Statistically significant correlation (p value <0.05) was observed between age and H wave minimum latency. Statistically non significant (p value >0.05) but fixed trends were observed between anthropometric measures and sural SNAP amplitude or H wave minimum latency. No correlation was observed between anthropometric measures and sural CV or H/M ratio or H wave maximum amplitude. **Conclusion:** Study concluded that as age advances H wave minimum latency prolongs. There are no significant height, weight, BMI related changes in sural and soleus H-reflex study.

Key words: *Action potential, body mass index, conduction velocity, H-reflex study, sensory nerve*

INTRODUCTION

Nerve dysfunctions begin usually in sensory nerves in lower extremity. Systemic illness like diabetes mellitus shows axonal neuropathies that can be diagnosed earliest by sural nerve conduction studies (NCS) and H-reflex studies. Both exhibit highest diagnostic sensitivity. [1,2] Differences in NCS values reported in literature can be attributed to various factors like demographic, anthropometric and different techniques. [3] Despite corrections made for age, height, gender and temperature, differences still persist in sensory and motor nerve amplitudes. [4] This often leads to misclassification errors and hence decreases sensitivity and specificity of the electrodiagnostic (EDX) tests. [5] Influence of age and height on NCS variables often concludes that, former is negatively correlated with conduction velocity (CV) and amplitude and later is negatively correlated with CV but positively correlated with amplitude. [5,6] Few studies have tried to explore association of these factors with soleus H-reflex study variables. [7,8] Thus association of anthropometric factors with H-reflex study remains less explored domain. Present study was conducted to evaluate impact of age, height, weight and BMI upon H-reflex and sural sensory nerve conduction (SNC) study measures among healthy central Indian population.

MATERIAL AND METHODS

Fifty healthy adult participants were recruited in this study following strict exclusion criteria. Most of them from hospital staff, medical students, and relatives of patients. They underwent a thorough history taking and neurological examination by consultant physician to rule out any evidence of neuromuscular or musculoskeletal disorder. Participants with history of systemic illness like diabetes mellitus, thyroid diseases, malignancies, and chronic alcohol abuse were excluded from the study. Age, sex, height and weight were recorded prior EDX tests. BMI was calculated as weight in Kg divided by height in meter square (Kg/m^2). An informed written consent was obtained from all the participants. EDX procedures were done by same electromyographer on same electromyograph (RMS-EMG-EP Mark-2) manufactured by Recorders & Medicare systems Chandigarh, India. Constant room temperature was maintained at 28 degree centigrade. Approval from Institutional Ethics Committee was obtained. Study was conducted according to guidelines by world medical declaration of Helsinki.

EDX procedures

We adopted standard techniques by Preston DC and Shapiro BE for nerve conduction studies. [9]

1. Recording of sural SNC study- Antidromic method of stimulation was used. Filters were set at 20 Hz to 3 KHz and sweep speed was 2 ms per division. Duration of stimulus was at 100µs. Sural nerve was stimulated in lateral calf at distance of 14 cm from active cathode electrode placed at lateral malleolus. Reference anode electrode was placed 3cm away from cathode. Twenty five stimuli were averaged to obtain a base to peak sural SNAP (sensory nerve action potential). Onset latency marker was placed at first deflection in the SNAP.
2. Recording of soleus H-reflex study - Filters were set at 2Hz with sweep speed at 10 ms per division and duration of stimulus at 1ms. Posterior tibial nerve was stimulated in popliteal fossa by percutaneous bipolar electrical stimulation and H wave recorded between active electrode placed over the soleus and reference at tendoachilles. Site of minimal threshold was obtained initially by moving stimulator in popliteal fossa. Three consecutive stimuli were averaged to obtain one H wave response. Successive responses were obtained by increasing strength of stimulus by 2-3 milliampears (mA). Total ten responses were averaged on rastred scale to obtain single H wave response. H latency was marked as first deflection in the waveform. Maximum H wave amplitude was obtained by selecting the highest peak to peak H wave out of ten. Ratio of maximum H wave to maximum M wave was expressed as H/M ratio.

Sural CV, SNAP, H wave minimum latency, H wave maximum amplitude and H/M ratio were obtained from EDX studies. Data was stored in excel sheet for further analysis.

Statistical analysis

Data obtained from sural SNC and soleus H-reflex study was analyzed using Statistical Package for Social Sciences (SPSS) 10.0 version. Demographic data was presented as obtained from descriptive analysis results of the study group. Data was normally distributed. Reference limits were derived from mean ± 2Standard deviation (SD). Correlation coefficient was derived between different anthropometric measures and NCS measures. Degrees of Coefficient of correlation (r) were graded into low (0.29 ≥ absolute value r ≥ 0.1), moderate (0.49 ≥ absolute value r ≥ 0.3) and substantial (absolute value of r ≥ 0.5). [10]

RESULTS

Fifty participants (47 male and 3 female) aged 21 to 60 years were included in the study. Mean values with standard deviations and range of values for age, height, weight and BMI are mentioned in Table 1.

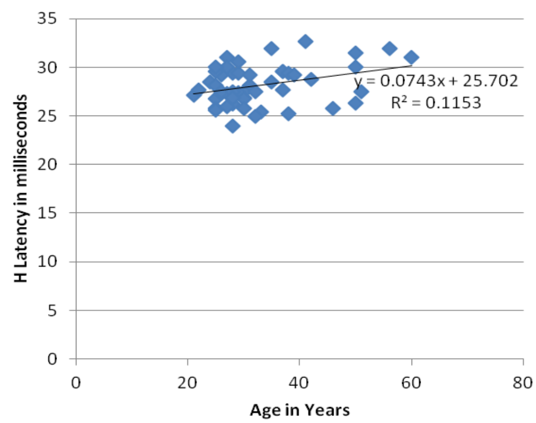
Table 1: Anthropometric profile of participants (N=50)

Basic data	Mean ± SD	Range
Age (years)	33.02 ± 9.2	21 - 60
Height (cms)	166.04 ± 4.9	158 - 178
Weight (Kgs)	58.04 ± 8.74	43 - 80
BMI (Kg/m^2)	21.08 ± 3.24	15.9 - 28.68

Nerve conduction study parameters for sural SNC and H reflex study are depicted in table 2. It included range, upper or lower cut off and mean ± SD values for sural CV, SNAP amplitude, H wave minimum latency, H wave maximum amplitude, and H/M ratio. Data was recorded from both sides. No statistically significant differences (p value > 0.05) were observed when NCS variables were compared side to side.

Correlation of age, height, weight, and BMI with sural SNC and H-reflex study measures is shown in table 3. Age was moderately correlated with H latency on both sides. A positive correlation (left side r=0.339, right side r=0.416) between age and H latency was observed. Low negative correlation (left side r= −0.179, right side r= −0.27) was observed between age and H wave amplitude. No correlation was observed between age and sural SNC measures except with right sural SNAP amplitude (r= −0.266). Low negative correlation was also observed between height and left sural CV and SNAP amplitude. Low positive correlation was observed between height and all H-reflex study measures (r value > 0.1). No correlation was observed between weight and NCS variables except right sural CV and left sural SNAP. Observations for correlation between BMI and NCS variables were inconsistent from one side to another side. Only sural SNAP showed a low negative correlation.

Graph 1: Correlation of age with H wave minimum Latency



(Graph 1 shows a scatter plot with positive trend between age and H wave minimum latency on right side. Linear regression equation with r^2 value is shown)

Table 2: Measurements of Sural SNC and Soleus H reflex study (N=50)

NCS	Variables	Range (Min-Max)		Reference limit α		Mean ± SD	
		Left	Right	Left	Right	Left	Right
Sural sensory nerve conduction study	Conduction velocity (CV) in m/s	42.2-68.6	40-65.5	46.09	45.76	51.46 ± 5.37	50.86 ± 5.10
	SNAP amplitude in µV	8.1-39.3	8.1-26.8	8.92	9.17	16.32 ± 7.40	14.38 ± 5.21
Soleus H - reflex study	H wave Minimum latency (ms)	24-32.7	24.2-33.5	30.16	30.17	28.15 ± 2.01	28.15 ± 2.02
	H wave amplitude (mV)	0.4-14	1.2-15	2.19	2.21	5.35 ± 3.16	5.49 ± 3.28
	H/M ratio	3.07-67	8-80	15.34	14.41	31.2 ± 15.86	33.96 ± 19.55

(**Reference limit α** were calculated by adding value of 2 SD to mean value in case of latencies, and deducting 2 SD value from mean values in case of conduction velocity, amplitudes and ratios.)

Table 3: Correlation of age, height, weight and BMI with sural sensory and H-reflex study parameters

NCS	variables	Correlation coefficient (r)							
		Age		Height		Weight		BMI	
		Left	Right	Left	Right	Left	Right	Left	Right
Sural SNC	CV	−0.002	−0.03	−0.178	0.0179	0.07	−0.137	0.143	−0.137
	SNAP amplitude	−0.094	−0.266	−0.15	0.052	−0.166	−0.088	−0.11	−0.108
Soleus H reflex study	H Minimum Latency	0.339*	0.416*	0.218	0.266	−0.039	0.016	−0.124	−0.084
	H amplitude	−0.079	−0.27	0.124	0.075	−0.071	−0.141	0.124	−0.173
	H/M ratio	−0.078	−0.086	0.157	0.20	0.037	0.009	−0.23	−0.08

(* suggest statistically significant values (p value <0.05), NCS=Nerve conduction study, SNC= sensory nerve conduction, CV=conduction velocity, SNAP-sensory nerve action potential, and H/M ratio= ratio of maximum H wave amplitude to maximum M wave amplitude)

DISCUSSION

Reference data is an essentiality in reporting cases referred to clinical neurophysiology laboratory. In present study, we mainly focused on evaluating the impact of age, height, weight and BMI on sural sensory and soleus H-reflex study variables. Reason being they are affected earliest in peripheral neuropathies. [2]

Impact of age: Age showed moderate positive correlation with H wave minimum latency, a low negative correlation with SNAP & H wave amplitudes and no correlation with sural SNCV & H/M ratio. Statistically significant (p value < 0.05) correlation was observed between age and H wave minimum latency. Findings were in agreement with previous studies [3,8,11] and against Awang MS et al. [6] Reduced SNAP amplitudes with increase in age were similar to S Saeed et al, Fuji Maki Y et al. and Chi-Ren Huang et al. We could not observe negative correlation as observed by Awang et al between age and sural CV. Chi-Ren Huang et al. found a substantial positive correlation between age and H wave minimum latency. He observed that there was increase in H-latency by 0.07ms per year as age advances. [8] Several age-related changes affect Hoffman reflex pathway involving afferent volley, efferent fibers and segmental interneuron. [12] As a result of which there is structural neural reorganization with progressive loss of largest fibers. [13] Increased incidence of neuronal remodelling leads to shrinkage of axonal diameter and reduced internodal length. [14] In view of these facts it is likely that H wave latencies will be prolonged as age advances. Stetson DS et al. also observed neuronal remodelling with increase in age. Apart from loss of nerve fibers and reduced axon diameter, changes in fiber membrane also contributed to the process. [5] These changes during remodelling causes reduced Sural SNAP amplitude as age advances. No correlation between age and sural CV, H wave maximum amplitude may be attributed to smaller sample size in the study.

Impact of height: Although Height showed low negative correlation with sural SNCV, SNAP amplitudes and low positive correlation with H wave minimum latencies, H wave amplitudes, and H/M ratio, it was statistically insignificant. Our findings of sural sensory conduction are in agreement with previous studies. [3,5,15,16] A negative association between distal nerve fiber diameter and height may best explain reduced SNAP amplitude in sural nerve. [3,5] Campbell WW et al. hypothesized that the height influence reflects abrupt, rather than gradual, tapering of axons distally that may help explain the decrements in sural conduction velocity from proximal to distal nerve segments. [17] With similar hypothesis Soudmand R et al. explained effect of height on late responses i.e. H wave minimum latency and F wave latency. [18] We could not explain the low positive trend observed between height and H wave maximum amplitude, H/M ratio. Both measures are affected largely by pre-synaptic inhibition and facilitation contributed by postural anxiety, training exercises and age related neuronal remodelling. [19, 20]

Impact of weight and BMI: No significant Correlations were observed between weight, BMI and NCS measures. There was asymmetry in trends observed from left and right side. Only sural SNAP amplitude showed a low negative correlation, although it was statistically not significant. Findings were corroborative with Buschbacher RM et al. He found significant negative correlation between BMI and sensory, mixed nerve amplitudes including sural nerve, with 20-40 % reduced mean values in obese compared to thin individuals. It might be due to amplitude attenuation by thicker subcutaneous tissue in the person with higher BMI. [7] No correlation was noted between BMI and sural nerve conduction velocity or H-reflex latency. This is in contrast with Pawar et al who observed variation between BMI and CV. He attributed his findings to presence of epineurium fat. [21]

Striking feature of current study is that, it assessed Soleus H-reflex study parameters including H wave maximum amplitude and H/M ratio apart from H wave minimum latency. Only age showed significant influence on H wave latency. None other parameters were significantly affected by any of the anthropometric measures. Thus future studies with larger sample size exploring this domain are required to explain the effect of age, sex, height and weight.

CONCLUSION

Present study concluded that as age advances, H wave minimum latency prolongs. Fix trends were present in most of the remaining sural and H-reflex study measures, although they were statistically insignificant. Moderate correlation (although statistically not significant) was observed between Sural SNAP amplitude and anthropometric factors (Age, height, and BMI).H wave maximum amplitude or H/M ratio were not affected by Height and BMI. Effect of height and BMI on these two H-reflex study parameters needs further studies with larger population.

Limitation of study

Unequal gender distribution remains major limitation of study. Although gender influence has been reported in literature, it mainly affects motor nerve conductions. Its impact on sural sensory and soleus H reflex study had been secondary to age and height variables. [8]

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