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Effect of Exteroceptive and Proprioceptive Sensory Stimuli on H Reflex and on Excitability of Nerve

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ABSTRACT

Objectives To find out the effect of exteroceptive and proprioceptive stimuli on H reflex latency and on excitability of nerve and to compare these effects with different exteroceptive and proprioceptive stimuli., **Method and Procedure**: A sample of 30 normal healthy female subjects with age group between 19–25 years participated in study. Each subject was given different exteroceptive (Hot Pack, Cold Pack) and proprioceptive (Quick Stretch, Weight bearing) stimuli. For each stimuli pre and post readings were taken for H reflex latency and amplitude of H/M which suggests excitability of nerve. The effects were then analyzed for each stimulus and compared.,**Results & Conclusion:** There was significant increase in the H reflex latency with cold pack and weight bearing. H/M ratio decreased with cold pack, quick stretch and weight bearing. On comparing the effect of different stimulus there was significant change in the latency with cold pack and hot pack and in the H/M between cold pack and hot pack and weight bearing. Thus with this study we can say that there is change in the latency of H reflex and on the excitability of nerve with different exteroceptive and proprioceptive stimuli.

Key Words: H- reflex latency, Excitability of nerve (H/M), Exteroceptive stimulus, Proprioceptive stimulus.

INTRODUCTION

Our nervous system acts like a telephone system where information is transmitted from and to the brain. Any input which is given to the body from outside or inside the body brings changes in the output from the brain. In various neurological disorders there is problem in various sensory systems and also in motor response, affecting purposeful activity. In these cases treatment introduce the information to the client in the form of sensory input, the information is then transuded into chemical and electrical transmission and through ascending and descending pathways brings a response[1].

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H reflex is an electrophysiological study which tells about the peripheral nerve excitability with different sensory stimulus. Paul Hoffman described H-reflex in 1918. It is a monosynaptic reflex elicited by sub-maximal stimulation of the tibial nerve and recorded from the calf muscle[2]. H-reflex is extensively used as both a research tool and clinical tool[3]. H-reflex is the electrical analogue of the monosynaptic stretch reflex (Knee jerk reflex) evoked by electrically stimulating the afferent nerve instead of mechanically stretching the muscle spindle[4].

H-reflex involves conduction from the periphery to the spinal cord[5]. The arc is that the stimulus travels along the Ia fibers, through the dorsal root ganglion and is transmitted to the anterior horn cell which fires it down along the alpha motor axon to the muscle. The outcome is a motor response. H-reflex is easily obtained in the soleus muscle[2].

H reflex is accompanied by a motor wave M wave which is visible when the stimulation strength is increased from low stimulation

strength. H reflex also measures the excitability of the nerve by estimating the peak to peak maximum H reflex amplitude to the M wave amplitude. It estimates the motorneuron pool activation and thus tells about excitability[2].

The other H reflex parameter is the latency which measures nerve conduction along the entire length of the afferent and efferent pathways and is thus important in determining the peripheral and CNS disorders.

H reflex is highly modifiable by peripheral sensory inputs and the descending postural commands and is also modified by age, gender, body mass index, skin temperature and height[6].

Various authors have studied the effect of different sensory stimulus on H reflex parameters. Susan Dewhurst et al 2005 studied the effects of temperature and reported that warming had no effect on H-reflex output in any group, cooling increased H-reflex output only in younger group. In both groups H latency increased with cooling and reduced with warming[7]. Calancie et al 2000 had studied the effect of lower extremity load (50%, 75%,100%) on motorneuron pool excitability in healthy individuals with four different stimulus (soleus H- reflex, soleus H- reflex with vibration, Achilles tendon reflex, Quadriceps tendon reflex) and concluded that load had no effect on the any of the reflexes[8].

Our sensory system is divided into exteroceptive and proprioceptive system.

Exteroceptors include the skin thermoreceptors. They are of two type one for perceiving cold and another for perceiving hot. They are the receptive portion of the sensory neuron where warmth receptors are unmyelinated C fibers. Receptor for cold are small thin myelinated type A delta fibers which stimulate at around 15^0C and reaches peak stimulation at around 24^0C. Warmth receptors are stimulated at around 30^0C and fades at around 45^0C[9].

Cold and warmth receptors are stimulated by the change in the rate of intracellular chemical reaction. When the sensory stimulus is of optimal intensity it results in the change in the voltage of the membrane, and generates receptor potential and when it rises above the threshold elicits action potential in the nerve fibers, and transmitted towards the CNS.

Heat and cold signals are carried by anterolateral pathway. The anterolateral fibers originate in the spinal cord mainly in dorsal horn lamina I, IV, V and VI.They reach into brain in the form of anterior and lateral spinothalamic tract. The tactile signals are transmitted into the ventrobasal complex and from here to the sensory cortex along with the signals from the dorsal column[10].

The deep sensory receptors (proprioceptors) include muscle receptors and the joint receptors. Muscle receptors include muscle spindle, Golgi tendon organs, free nerve endings and pacinian corpuscles whereas joint receptors are Golgi type endings, free nerve endings, ruffini endings and paciniform endings.

Proprioceptive sense is carried by the dorsal column pathway. The nerve fibers of first order neuron enter the dorsal white column of the same side. The fibers travel upward as fasciculus gracilis and fasciculus cuneatus.The axons of second order neuron called internal arcuate fibers cross median plane and ascend as single compact bundle, the medial lemniscus. Then these fibers terminate by synapsing on the third order neuron in the ventral posterolateral nucleus of the thalamus. Then the axons pass through the posterior limb of internal capsule and corona radiata to reach the somesthetic area in the postcentral gyrus of the cerebral cortex[10].

STATEMENT OF THE STUDY

This study aimed at finding and comparing the effect with different exteroceptive and proprioceptive stimulus on latency and on excitability of nerve.

INCLUSION CRITERIA

Normal BMI subjects between19– 25 years, right foot dominant (based on waterloo footedness questionnaire) and limb length and leg length between 75-99 cm and 27-49 cm respectively.

EXCLUSION CRITERIA

Subjects having Neurological disorders, limb length discrepancies, any mental disorder, hyper sensitive to heat and cold, recent trauma and systemic illness.

METHOD

Subjects were made to lie down and the limb length and leg length was measured. Subjects were given explanation about the procedure. Right posterior tibial nerve was stimulated at the popliteal fossa. Latency and amplitude of H and M wave was recorded.

PROCEDURE

Subjects were conveniently selected based on inclusion and exclusion criterion. Procedure was explained and their consent was taken. They were made to lie down prone in a comfortable position to record the base value, posterior tibial nerve was stimulated in popliteal fossa and recording of H reflex latency and amplitude of H and M wave was done. After this lateral aspect of leg which corresponds to the cutaneous supply of the posterior tibial nerve is stimulated with cold pack for 5minutes to activate the cold receptors, immediately after which recordings were done both for latency and amplitude. Then a gap of 10 minutes was given to stop the activation of these receptors. Again a basal recording was done followed by application of hot pack for 8minutes to stimulate the heat receptors, and then both recordings were taken. From the data, H/M amplitude ratio was calculated to measure the excitability of nerve.

After a gap of 10 minutes a basal reading was taken then the subject were given a series of proprioceptive stimulus which are quick stretch for 10 times to stimulate the deep muscle receptors and recording of latency and amplitude of H and M wave was done. With gap of 10 minutes basal recording of same parameters was done and then subject was made to stand on floor for 5 minutes in full weight bearing and after which subject was made to lie down prone again and readings were taken.

DATA ANALYSIS AND RESULT

The data was analyzed using SPSS 10.0 software package. Paired t test was used for analyzing the dependent variables. One way Analysis of Variance (ANOVA) and Post hoc analysis by Schiffe's test was used for comparing the values of H reflex latency and ratio of amplitude of H/M. Mean and standard deviation of H reflex latency and H/M without application of any stimulus and after application of each exteroceptive (Hot pack, Cold pack) and proprioceptive (Quick stretch, Weight bearing) was calculated for both groups. To see the effect pre and post values were compared and to compare the effect of exteroceptive and proprioceptive stimulus multiple Schiffe's test was used. A 0.05 level of significance was used for all comparisons.

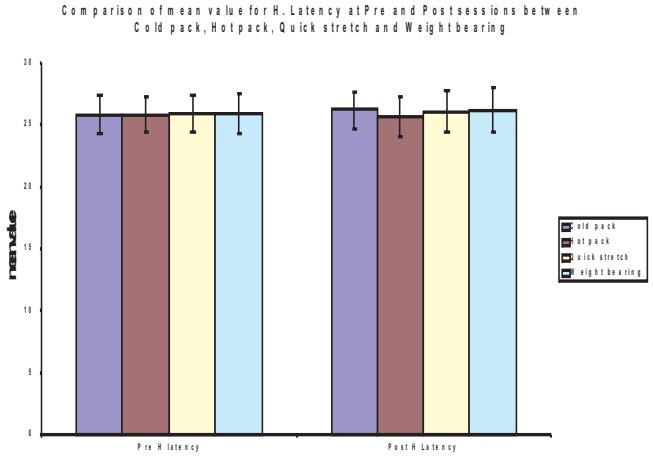
	MD (PRE-POST) H LATENCY	Mean difference ± SD	Pre Vs Post	
			T value	P value
COLD PACK	Pre-Post MD	0.40 ± 0.31	-7.016	P < 0.05
Hot Pack	Pre-Post MD	-0.12 ± 0.55	1.221	P > 0.05
Quick Stretch	Pre-Post MD	0.17± 0.65	-1.468	P > 0.05
Weight Bearing	Pre-Post MD	0.29± 0.74	-2.155	P < 0.05

	MD (PRE-POST) H/M	Mean difference ± SD	Pre Vs Post	
			T value	P value
COLD PACK	Pre-Post MD	-0.22 ± 0.53	2.337	P < 0.05
Hot Pack	Pre-Post MD	0.19 ± 0.77	-1.348	P > 0.05
Quick Stretch	Pre-Post MD	-0.12± 0.24	2.800	P < 0.05
Weight Bearing	Pre-Post MD	-0.22± 0.36	3.412	P < 0.05

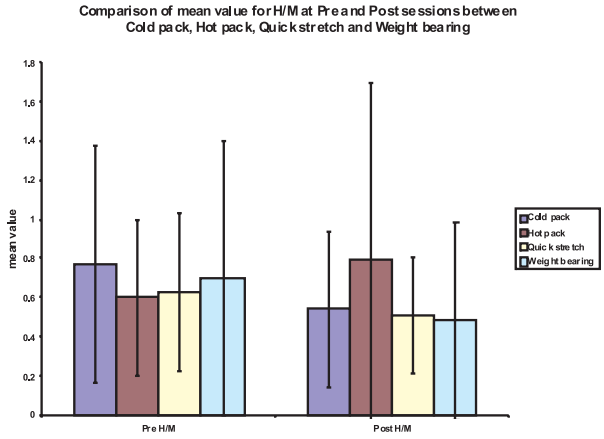
Table 1 shows the mean difference, t value and p value of pre and post H latency with cold pack, hot pack, quick stretch and weight bearing. Significant changes were found in the pre and post values of H latency with cold pack and weight bearing at $p<0.05$.

Table 2 shows the mean difference, t value and p value of pre and post H/M with cold pack, hot pack, quick stretch and weight bearing. Significant changes were found in the pre and post values with cold pack, quick stretch and weight bearing at $p<0.05$.

Graph 1



Graph 2



DISCUSSION

This was an experimental study which determined the effect of exteroceptive and proprioceptive stimulus on H reflex latency and on H/M or excitability of nerve and to compare the H reflex latency and excitability of nerve with different exteroceptive and proprioceptive stimulus.

Thirty normal female subjects were taken on the basis of inclusion and exclusion criteria. The study was conducted at approximately the same time everyday. In all subjects measurements of H reflex latency and ratio of H/M which measures excitability of nerve was attained, analyzed and compared with exteroceptive stimulus (Cold Pack, Hot Pack) and proprioceptive stimulus (Quick Stretch, Weight Bearing).

After analysis of data it was found that there were significant changes in the H reflex latency with Cold Pack and Weight Bearing. When excitability of nerve was analyzed it was found that there was significant change in the excitability of nerve with Cold Pack, Quick Stretch and Weight Bearing. On comparison of H reflex latency with different exteroceptive and proprioceptive stimulus, there was significant changes in the mean difference (MD) of H reflex latency between Cold Pack and Hot pack. On the excitability of nerve there was significant difference in the mean difference of excitability of nerve between Cold Pack and Hot Pack and between Hot Pack and Weight Bearing.

In the current investigation, the result showed a significant increase in the H reflex latency with Cold Pack and Weight Bearing. However there was decrease in the H reflex latency with Hot Pack but the reduction in the latency was not statistically significant. Similarly with Quick Stretch the H reflex latency increased but was not statistically significant. With comparison with different stimulus, there was significant change in the H reflex latency between Cold Pack and Hot Pack, but noteworthy is that other stimulus failed to significantly alter the latency.

The change in the latency with different temperature could be due to the change in the rate of intracellular chemical reaction[46]. One probable explanation for increase in the H reflex latency with Cold receptors stimulation is that there is an increase in skin surface resistance with cold thus latency is increased or this could be due to the prolongation of the time for opening of the voltage gated sodium channel, thus reducing the

conduction velocity and increasing the H reflex latency. This result is partially supported by Susan Dewhurst et al (2005) who concluded in their study that cooling increased H reflex latency (+5.3%) but the result of warming in their study had decreased the H reflex latency (-5.5%)[7] which is not in accordance to the result of the present study.

The result from the present study suggested significant decrease in the H/M or in the excitability of the nerve with Cold Pack, although there was increase in the H/M ratio with Hot Pack but it failed to achieve a significant value. Both proprioceptive stimuli (Quick Stretch, Weight Bearing) significantly decreased the H/M ratio. On comparing the H/M with different stimulus, it was found that there was significant change in the mean difference of H/M between Cold and Hot Pack and between Hot Pack and Weight Bearing.

One reason for this kind of a response could be that the quick stretch was given with knee extension and continuously for 10minutes so this could have inhibited the excitability of the motor neuron pool.

Takeshi Sato et al (1997) studied the effect of skin temperature variation from 33^0ze to 22^0ze on motor neuron pool excitability and found that motor neuron pool excitability exhibited maximum excitability when skin temperature was 26^0ze and decreased with temperature above and below 26^0ze[11]. In contrast to the result of the present study, Calancie B et al (2000) found that under static condition lower extremity motor neuron excitability is not affected by superincumbent load[8]. Egawa et al (2003) showed in their study that somatosensory input like weight bearing inhibits the soleus H reflex circuit during upright standing in humans. The explanation offered for this inhibition is the effect of segmental and supraspinal factors. The segmental factors consist of inhibitory interneuron and presynaptic inhibition of the Ia terminal and suggested that all these factors integrate in a presynaptic manner in the spinal cord to modulate the excitability of the alpha motor neuron pool of the soleus to allow a static posture to be maintained in humans[6].

Thus we can accept our null hypothesis and alternate hypothesis partially. The alternate hypothesis is valid in terms of changes in the H reflex latency with Cold Pack and Weight Bearing and on the H/M with Cold Pack, Quick Stretch and Weight Bearing. Between the different stimuli, alternate hypothesis is accepted for latency between Cold Pack and Hot Pack and for H/M between Cold Pack and Hot Pack and between Hot Pack and Weight Bearing. Null hypothesis is accepted for latency and H/M with Hot Pack. The latency of H reflex also accepts the null hypothesis with different stimuli.

To summarize the result of the study we can say that there was a change in the latency of the H reflex and on the ratio of H/M with different exteroceptive and proprioceptive stimulus.

CONCLUSION

Significant effects were found in H reflex latency with Cold Pack and Weight Bearing and on H/M or excitability of nerve with Cold Pack, Quick Stretch and Weight Bearing.

The Multiple Comparison Schiffe's test results showed significant change is produced in H reflex latency with Cold Pack as compared to Hot Pack and other proprioceptive stimulus. Significant change in H/M or excitability of nerve was found with Cold Pack, Hot Pack and Weight Bearing.

Thus, it can be concluded that exteroceptive and proprioceptive stimulus has effect on H reflex latency and on the H/M ratio and can be used in clinical settings as a treatment measure to modify the motor response in neurological disorders.

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