Behaviour of H-reflex amplitude in the individual with Spinal Cord Injury: An observation study.

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ABSTRACT

Aim: This study aimed to observe the reflexive changes in individuals with spinal cord injury at 3, 6, and 9 months of injury following SCI. **Methodology:** It is an observational study, Ten SCI subjects aged between 18 to 60 years are willing to participate. Thoracic level of SCI, aetiology from trauma, vascular or orthopaedic pathology, and participants undertaking the physiotherapy treatment daily were included into the study. Patients with any other psychological and other neurological disorder, above 60 years were excluded from the study. Participants were in a prone lying position and the area to be assessed was cleaned with spirit to avoid hair resistance. Soleus H-reflex amplitude was elicited from the right leg at 3,6 and 9 months respectively. **Result:** Descriptive Statistics was obtained and the normality of the data was checked using the Kolmogorov-Smirnov Normality test. Within-group comparison was done by Freidman test and post hoc analysis was done using Dunn's Multiple comparison test. It is seen that there was a significant difference ($p<0.0001$) H reflex amplitude at 3rd, 6th, and 9th post injury. **Conclusion:** The finding of the study revealed that there is gradual increase in H-reflex amplitude in individuals post-injury. Therefore, the spinal neurons gradually regain their excitability and recovery takes place over the period.

KEYWORDS- Hoffman's reflex, Electrodiagnostic measure, H-reflex amplitude, Maximal reflex activation, Spinal cord injury, H-reflex.

INTRODUCTION

Introduction:

Rhythmic movements such as walking is not possible post-injury as the neural circuits that control the motor instructions is damaged.[1] In individuals with an SCI on a higher level the complications cited are orthostatic hypotension and autonomic hyperreflexia causes hypertensive attack, it is transient in nature, and due to the decreased tonus of the sympathetic nerves in chronic cases it shows a trend of hypotension.[2]

The exact information for incidence for SCI in India and most of the developing countries is very little known as there is no national database. In the year, 1995 an international conference was held in New Delhi named Spinal Injuries Management a report estimated 15 new cases of SCI per year. In recent times there were approximately twenty thousand new cases each year among which 60-

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70% of individuals suffering from SCI are poor and illiterate,[3] higher number of males from the age group of 16-30 years are affected indicating the high incidence among the individuals who are active and into producing population of the society the reason could be increasing incidence of road traffic accidents. WHO predicts RTA to be the 3rd cause for most of the disabling conditions by the year 2020 as the incidences of this are on a rise in India and other developing countries.[3]

Between the years 1955 to 2006 in Australia survival rate for individuals suffering from tetraplegia was 91.2% whereas 95.8% for those suffering from paraplegia this was reported based on the clinical outcomes of patients who suffered SCI. According to the ASIA impairment scale patients in grade D requiring a wheelchair for activities of daily living have a 75% life expectancy and patients who do not require a wheelchair and catheter have a 90% life expectancy. it is a consistent finding that the risk of death is 3 times higher in patients with complete spinal cord injury as compared to incomplete SCI based on a follow-up period of 10 years, thus concluding the severity of the injury influences survival. The level at which the injury took place is also important, there is a higher mortality rate in patients with more cephalad levels of injury.

In managing SCI in a clinical setup, the outcomes used for neurological testing using the ASIA scale are usually done 72 hours after the injury this period has been stated as the most precise period for assessment impairments that are neurological in origin.[4]

A compound muscle action potential elicited by electrical stimulation of afferent fibers in the mixed nerves with subsequent recruitment of motor neurons through monosynaptic connections in the spinal cord is known as Hoffman or H-Reflex it provides a window to look into the spinal cord to observe the neuro-modulatory process[5] this study has been employed for monitoring the excitability of anterior horn cell pool in different CNS disorders such as stroke, dystonia, parkinsonism and other cerebellar disease. In patients with CNS lesions with upper motor neuron signs, the H reflex may be abnormally widespread and can be elicited in muscles in which it is not normally elicited, such as tibialis anterior and small hand muscle. H reflex is depressed during spinal shock and cataplexy. Using the H reflex, Jin et al introduced a new sensitive measure to evaluate S1 radiculopathy.[6] Hesham N Alrowayeh et al reported in their study that H reflex amplitude was more evident than changes in patients with radiculopathy. They also noticed that changes in amplitude and latency were more associated with more chronic and/or severe cases of radiculopathy.[7] As we all know spinal cord injury is devastating and affects the individual's life making them dependent. H-reflex is helpful in observing monosynaptic pathways in patient with spinal cord injury and will give us the prognosis of the disease.

METHODOLOGY

An observational study was conducted on individuals with Spinal cord injury at Physiotherapy OPD of the tertiary care hospital at Ahmednagar. A convenient sampling strategy was utilized to enroll subjects after obtaining the ethical clearance. Ten SCI subjects aged between 18 to 60 years participated in the study. Written informed consent was obtained in the regional language from all the participants. The demographic data including name, age, gender, address, level of injury, and dominance was noted. Participants were in a prone lying position and the area to be assessed was cleaned with spirit to avoid hair resistance. Unipolar stimulation, in which the cathode is placed over the nerve and the anode is positioned on the opposite side of the limb, is recommended in most situations to selectively activate Ia afferents at lower thresholds and to reduce the stimulus artifact. Electrode placement was done according to the standardized procedure to elicit the Soleus H reflex i.e. bipolar surface electrodes were placed

approximately 2 cm apart over the corresponding muscle belly and an inactive electrode was placed on the TA tendon. Ten soleus H-reflex were elicited from the right leg at 3,6 and 9 months respectively. H reflex is a monosynaptic reflex elicited by submaximal stimulation of the tibial nerve and recorded from the calf muscle. It is interpreted by the latency which is measured from the stimulus artifact to the first deflection from the baseline and amplitude is measured from base to peak of the negative phase or can be measured from peak to peak. The Intraclass Correlation Coefficients obtained for latency, amplitude and duration of the H-wave were 0.46, 0.97, 0.99 respectively. The H max /M max and Hslp/Mslp showed very good reliability i.e. ICC – 0.87 and 0.92 respectively.

RESULT

Descriptive statistics were obtained and the normality of the data was checked using the Kolmogorov-Smirnov Normality test. Within-group comparison was done by Freidman test and post hoc analysis was done using Dunn's Multiple comparison test. Categorical variables were measured by graphs and tables.

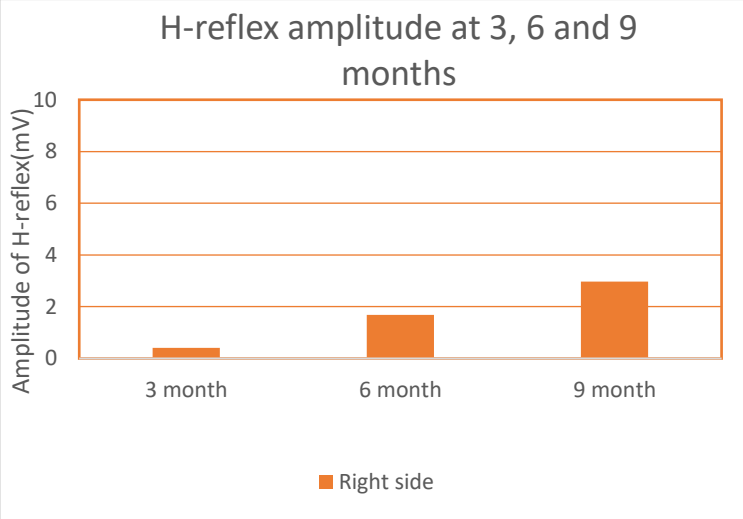
Table 1: Demographic characteristics of the subjects.

Age (in years)	31 ±5.03			
Gender (male: female)	6:4			
Level of Injury	T5	T6	T11	T12
	1	2	4	3
ASIA grade	A	B	C	
	5	3	2	

Table 2 and Figure 1: Shows that the Mean and Standard Deviation of H-reflex Amplitude values increased significantly post 9 months of injury using Friedman's Rank sum test. * denotes p value is significant ($p<0.05$)

H-reflex	3 months	6 months	9 months	p value
Right side	0.41± 0.14	1.68± 2.94	2.97± 3.62	0.0001*

Figure 1:



DISCUSSION

When the spinal cord is injured all the functions of the spinal cord below the level of injury are depressed as the result of spinal shock. Spinal shock may last from days up to several weeks. After SCI there is also a secondary injury mechanism that takes place further affecting the neurons and glia, the major event for secondary injury is cell death which can be because of various mediators induced by the injury, apoptosis and necrosis are the two leading originally identified mechanisms to follow SCI.[2] The series of cellular, molecular, and biochemical phenomena that continues to harm the cord after SCI is still referred with the term secondary injury in the field. Within a few minutes after primary injury secondary injury starts and may continue for weeks or maybe months leading to a cascade of progressive damage to the spinal cord around the lesion. Immediately after the injury, there is an initiation of the acute phase in

which there is damage to vasculature, imbalance of ions, accumulation of neurotransmitters, edema, influx of calcium, free radical formation, lipid peroxidation, inflammation and necrotic cell death.[4] Due to the injury there in disruption in the blood supply and hypo-perfusion and this is the early consequence of primary injury. In SCI cases there can be hypovolemia and hemodynamic shock due to excess bleeding and because of the compromised perfusion and ischemia, there is neurogenic shock. Vessels like anterior spinal artery that are large remains intact while damage to small vessels and capillaries susceptible to traumatic damage leads to extravasation of leukocytes and red blood cells.[2] Further disruption of the blood flow is because of edema and hemorrhage-induced vasospasm in intact vessels.[8] A study by Benito Penalva et al. analyzed the effect of 40 sessions of robotic treadmill gait training on TMS-mediated soleus H-reflex facilitation in a population of subjects with incomplete SCI. In that study, training improved a baseline deficit in the 'direct' (20 ms) facilitation time window, and this correlated with clinical improvement.[9] During spinal shock many electrophysiological studies vindicate supraspinal segmental inhibition with results of presynaptic inhibition and block monosynaptic and polysynaptic reflex arcs. Nevertheless, the spinal neurons gradually regain their excitability.

Similarly, we aimed to observe the reflexive changes in the individual with spinal cord injury. The mean score of H-reflex Amplitude improved significantly at 3, 6, and 9 months of injury. A study found that patients with complete SCI had significantly increased H-reflex ratio at short ISI compared with healthy and incomplete SCI subjects, whereas no significant differences in H-reflex recovery were found between incomplete SCI and the control group at short ISIs. This study revealed alteration in spinal reflex activity in SCI individuals which depends on the severity of SCI, but not the level of SCI.[10] These findings contribute to a better understanding of spinal reflex excitability regulation and could serve as electrophysiological measures of therapeutic interventions.

A study by Kumru et al aimed to evaluate the changes in the excitability of the Soleus H reflex circuit modifies according to severity and level of injury. And whether H-reflex and its prognosis depend on the level or the severity of the disease. The soleus H max and M max responses and the H reflex recovery curve at interstimulus intervals (ISIs) ranging from 50 to 1,000 ms were obtained in 38 individuals with Spinal Cord Injury and 18 healthy subjects. Comparison of complete and incomplete SCI was also analyzed. A smaller amplitude correlated with more severe SCI or more caudal lesion in the case of M_{max}. H-reflex recovery curve was increased significantly in complete SCI at ISIs < 500 ms and in incomplete SCI at ISIs>200 ms concerning healthy subjects. They concluded that the changes in spinal reflexes and its recovery curve after SCI depend on the severity, but not on the level of the lesion.[11] The resolution of spinal cord shock occurs over a period and it slowly transit showing the symptoms of spasticity. Meanwhile, the spinal neurons gradually regain their excitability by the mechanism of synaptic reorganization. The body is in a continuous process of repair and recovery after the injury.

CONCLUSION

The findings of the study revealed that there is a gradual increase in H-reflex amplitude in individuals post-injury. Therefore, the spinal neurons gradually regain their excitability and recovery takes place over a period of time.

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