Original Research Paper

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INNOVATIVE STUDY TO DEVELOP A SENSORIMOTOR WAVE (THE LOOP WAVE) FOR NEURO-DIAGNOSIS IN VARIOUS CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM DISORDERS: A CROSS POLLINATION DISCOVERY

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ABSTRACT Sensorimotor loop wave will be a single waveform of the combination of Motor evoked potential (MEPs) and the somatosensory evoked potential (SEPs). SEPs measure the electrical activity generated in the somatosensory cortex in response to sensory stimuli, often involving electrical pulses applied to peripheral nerves. MEPs measure the electrical activity of muscles in response to electrical or magnetic stimulation of the motor cortex. They are used to assess the integrity of motor pathways, diagnose motor neuron disorders, and evaluate conditions affecting the corticospinal tracts.The objective of the study is to develop the sensorimotor loop wave for the easy and accurate diagnosis in the neurological disorders of CNS and PNS.The study design is Innovative study. The study settings were Department of Physiotherapy, Punjabi University, Patiala and Medicaid, Mohali. The equipment used were Repetitive Transcranial Magnetic Stimulation, Laptop with MEP and SEP software. The results and findings of the study was that the combined use of stable MEPs and SEPs would be able to detect both the afferent and efferent conduction delay and failure in central motor pathways and sensory pathways to proximal and distal districts of upper and lower limbs through single waveform. The significance of the study is that the proposed Sensorimotor Loop wave would be the single test to detect the integrity of the somatosensory system and motor system. It would provide an extensive electrophysiological mapping of CNS and PNS in clinical application.

KEYWORDS : MEP: Motor Evoked Potentials, SEP: Somatosensory Evoked Potentials, CNS: Central Nervous system, PNS: Peripheral Nervous System, RTMS: Repetitive Transcranial Magnetic Stimulation

BACKGROUND

Neurophysiology is the scientific discipline within physiology that investigates the function of the nervous system, encompassing the study of neurons, synapses, neural circuits, and the electrophysical properties of nerve cells [1]. Clinical neurophysiological tests are diagnostic procedures used to evaluate the function of the nervous system. These tests provide valuable information for the diagnosis and management of various neurological disorders. EEG, MNCV, SNCV EMG and Evoked Potentials (MEPs, SEPs) are the common examples of neurophysiological examination [2]. Electrophysiological testing plays a crucial role in diagnosing and managing various neurological disorders by assessing the electrical activity of the nervous system. Electrophysiological testing provides valuable insights into the function and integrity of the nervous system, aiding in accurate diagnosis, treatment planning, and monitoring of neurological disorders [3]. It helps clinicians understand the underlying mechanisms of these conditions and guides interventions to improve patient outcomes.

Neurophysiological assessment has a rich history spanning centuries, evolving alongside advancements in technology and our understanding of the nervous system. The foundation of neurophysiology was laid in the 19th century by pioneers like Luigi Galvani and Emil du Bois-Reymond [4]. Galvani's experiments with frog muscles demonstrated the existence of bioelectricity, while du Bois-Reymond developed the capillary electrometer, enabling more precise measurements of electrical phenomena in living tissues. The development of the electroencephalogram (EEG) by Hans Berger in the 1920s revolutionized the field in early 20th century [5]. Berger's discovery of the brain's electrical activity opened new avenues for studying neurological disorders and brain function non-invasively. The mid-20th century saw significant advancements in nerve conduction studies (NCS) and electromyography (EMG) [6]. Techniques for stimulating nerves and recording muscle activity became more refined, leading to better diagnosis and understanding of neuromuscular disorders.

Evoked potentials emerged as a valuable tool for assessing sensory and motor pathways in the nervous system in late 20th Century. Visual, auditory, and somatosensory evoked potentials provided insights into conditions affecting these pathways, such as multiple sclerosis and peripheral neuropathies. The 21st century witnessed rapid technological advancements in neurophysiological assessment. Transcranial magnetic stimulation (TMS) gained popularity as a non-invasive method for studying and modulating brain function. Advanced imaging techniques, such as functional MRI (fMRI) and diffusion tensor imaging (DTI), complemented traditional neurophysiological assessments, offering a more comprehensive understanding of brain structure and function [7].

Motor Evoked Potentials (MEPs) play a crucial role in the assessment and management of central nervous system (CNS) disorders, offering valuable insights into the functional integrity of descending motor pathways from the brain to the spinal cord and peripheral nerves [8]. By eliciting MEPs through techniques such as transcranial magnetic stimulation (TMS), clinicians can evaluate the corticospinal tract's excitability and conduction, providing objective measures of motor system function. In CNS disorders such as stroke, multiple sclerosis, spinal cord injury, and epilepsy, MEPs serve as important diagnostic tools, aiding in lesion localization, prognostication, and treatment planning [9]. Moreover, MEPs can predict motor recovery and response to interventions, guiding rehabilitation strategies and informing clinical decision-making. Their non-invasive nature and ability to assess motor pathways' integrity make MEPs indispensable in understanding the pathophysiology of CNS disorders and optimizing patient care [10].

Somatosensory Evoked Potentials (SEPs) hold significant clinical value in the assessment and management of central nervous system (CNS) disorders, particularly in evaluating sensory pathways from peripheral nerves to the brain [11]. By stimulating peripheral nerves and recording electrical responses along the sensory pathway, SEPs provide objective measures of sensory system function. In conditions such as multiple sclerosis, stroke, spinal cord injury, and epilepsy, SEPs help localize sensory deficits, assess the extent of neuronal damage, and predict functional outcomes [12]. Additionally, SEPs aid in diagnosing and monitoring peripheral neuropathies, radiculopathies, and other sensory disorders. Their ability to detect subclinical abnormalities and quantify sensory impairments makes SEPs invaluable in guiding treatment decisions, evaluating therapeutic interventions, and predicting patients' neurological recovery [13]. Overall, SEPs contribute significantly to understanding the pathophysiology of CNS disorders and optimizing patient care through their non-invasive and objective assessment of sensory pathways.

Throughout its history, neurophysiological assessment has played a crucial role in diagnosing and managing neurological disorders, guiding treatment decisions, and advancing our understanding of the brain and nervous system. Continual innovation and integration of emerging technologies promise to further enhance the capabilities of neurophysiological assessment in the years to come.

Sensorimotor loop wave will be a single waveform of the combination of Motor evoked potential(MEPs) and the somato-sensory evoked potential (SEPs). SEPs measure the electrical activity generated in the somatosensory cortex in response to sensory stimuli, often involving electrical pulses applied to peripheral nerves [14]. MEPs measure the electrical activity of muscles in response to electrical or magnetic stimulation of the motor cortex. They are used to assess the integrity of motor pathways, diagnose motor neuron disorders, and evaluate conditions affecting the corticospinal tracts [15].

Objective of the Study

The objective of the study is to develop the sensorimotor loop wave for the easy and accurate diagnosis in the neurological disorders of CNS and PNS.

Methodology

Study design: Cross pollination innovative study.
Study settings: Department of Physiotherapy, Punjabi University, Patiala and Medicaid, Mohali.
Equipment used: Repetitive Transcranial Magnetic Stimulation, Laptop with MEP and SEP software, Electrodes, Gel and Micropore.

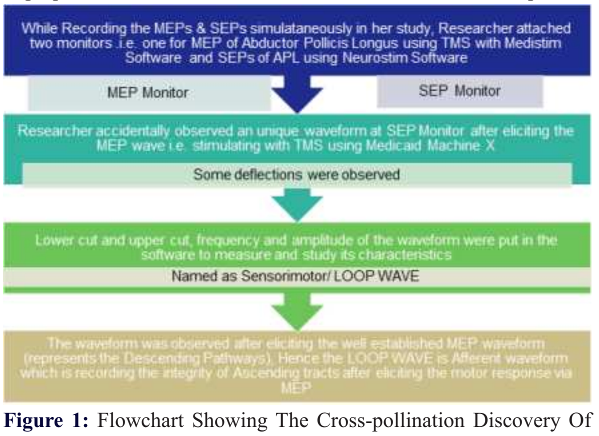

Figure 1: Flowchart Showing The Cross-pollination Discovery Of Loop Wave While Recording Meps And Seps In Healthy Individuals

Figure 2. (a). Mep Monitor **(b).** Sep Monitor

RESULTS AND DISCUSSION

This is the preliminary phase of the study.The waveform is under the rigorous study to establish its characteristic features. The separate computer interface and software is under the process which would be able to record the MEP and After MEP, the LOOP wave with the same monitor by adjusting the sensitivity, sweep phase and other parameters.

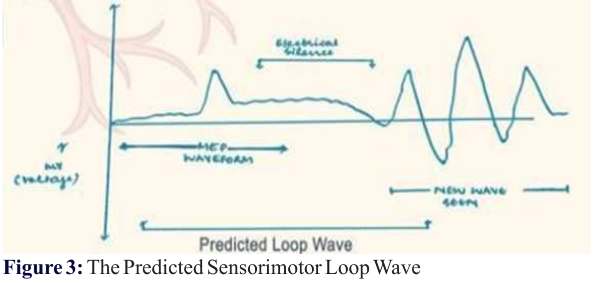

Figure 3: The Predicted Sensorimotor Loop Wave

Future Scope Of The Study

The Loop wave would be the single waveform to detect both the afferent and efferent conduction delay and failure in central motor pathways and sensory pathways to proximal and distal districts of upper and lower limbs through single waveform.

CONCLUSION AND IMPLICATIONS

The significance of the study is that the proposed Sensorimotor Loop wave would be the single test to detect the integrity of the somatosensory system and motor system. It would provide an extensive electrophysiological mapping of CNS and PNS in clinical application.

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Author Contributions

All authors equally contributed in the preparation of the article.

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Conflicts Of Interest

The authors declare no conflicts of interest.

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