Abstract

Over the past century, investigations to study and understand the mechanism underlying the physiology of the biological system are carried out extensively with the help of spectacular progress and recent advances in neuroscience. Although it a very challenging task yet it is very interesting area of research with optimum potential for different research groups. In this context, modeling of the nervous system has been proved to be an important theoretical tool to describe and understand the function and other physiological properties of the nervous system. The introduction of neuroengineering devices made scientific methods possible to understand and model the nervous system successfully. The utilization of the scientific knowledge has made possible to analyze the complexity of flow of neuro signals in the nervous system theoretically. Different electric circuit models were presented in this research work to study the physiology of normal peripheral nerves as well as disordered nerves affected by demyelination. The quantification of demyelination is made by using electric circuit model considering a nerve with bundle of axons which is equivalent to human nerve and verified experimentally by toad model. The interpretation obtained from the physiological studies of the electrical circuit models is applied for the recovery of the disordered demyelinated nerves. The physiologies of peripheral myelinated and demyelinated nerve are reviewed based on the previous works with the inclusion of different electric circuit models with a purpose to be applied in this research work. A comprehensive survey on some of the previous existing electric circuit model results in the introduction of a modified electric circuit model of a peripheral myelinated nerve considering certain electrical parameters which are responsible for demonstrating physical and thermodynamic properties, essential for appropriate functioning of the nerve impulse in a bundle of axons. The proposed model of myelinated nerve is further modified and used for designing an electric circuit model of a peripheral demyelinated nerve to study the physiology in a disordered nerve affected by demyelination. Demyelination is one of the root causes of different nerve diseases such as Guillain-Barre Syndrome (GBS) and chronic inflammatory demyelinating polyneuropathy (CIDP) which results in conduction block thereby reducing the nerve conduction velocity (NCV) in the nerves. The proposed demyelinated nerve model is used to quantify different nerve diseases from the NCV formulated by using the electric circuit model. The work is also extended to the formation of a recovery model by coupling a myelinated nerve with a demyelinated nerve theoretically with the use of an electric circuit model. The theoretical models are validated using isolated sciatic nerves of toad and the experiments are carried out 5-6 times to reduce any chance of error and obtain similar results to confirm our validation. The coupled model witnesses a recovery in peaks of amplitude of action potential as well as NCV in the disordered nerves.

Keywords- physiology, biological system, neuroscience, neuroengineering, quantification, demyelination, peripheral, myelinated, demyelinated, electric circuit models, recovery, Guillain-Barre Syndrome (GBS), chronic inflammatory demyelinating polyneuropathy (CIDP), nerve conduction velocity (NCV), coupled model, amplitude, action potential.