ABSTRACT

Until now, the biological information that has been made use for the development of artificial limbs based on electro-mechanical coupling is from EMG signals, EEG signal and/or local signals of neuronal excitation. While all these methodologies are successful experimentally, they also possess few drawbacks such as inability to pick up minute neuronal signals, corrosion of the internal electrode leading to toxicity and aberrant reading of those bio-signals. In the current study an innovative approach of developing an artificial limb based on change in pH at the neuromuscular junction (NMJ) has been proposed. In humans like any vertebrates, the motor movements of the appendages are commanded by the motor area of cerebral cortex voluntarily when a will to act is generated. This is followed by neuronal excitation that passes through NMJ to excite/contract different group of muscles. The muscle excitation is preceded by action potential development that is initiated, maintained and terminated by sequential ionic movements in and out of the muscle cell. The major ions involved are Na and K. The change in these ionic concentrations can lead to change in pH at the NMJ that can be interpreted as information sent by the brain. Thus it was hypothesized that the changes in the pH can accurately mimic the intended changes in the amputated limb muscles, and therefore can be used to turn the user's desired motion into actual motion of the limb prosthesis. Briefly, the study utilized a pH-to-voltage converter which converts the pH signals of the neuro-muscular junction into an electrical signal (voltage change). A cut-off voltage was assigned above which the limb moves that exactly simulates the role of action potential in muscle contraction. The movement of the artificial limb was implemented by the usage of a DC motor that can be switched on or off through a microcontroller above or below the cut off voltage respectively. The microcontroller, AT89C52 was used for function coding of the system that regulated the movement amplitude, and range for the prosthetic limb. The connection between the DC motor and microcontroller was implemented using ICL293D integrated circuit. The overall success of the study lies in the efficiency of the sensitivity of pH meter that can record the smallest change in pH so that a high fidelity prosthetic limb motion can be generated. This study can be further implemented by using ion specific electrodes to monitor the change in specific ion concentration as information/input. A high fidelity system thus developed can be projected to the movement of fine moving prosthetics like digits.

Keywords: prosthetic limb, neuromuscular junction, voltage-regulated limb movement

List of figures

List of tables