Functional Electrical Stimulation
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Abstract—Functional Electrical Stimulation (FES) is the use of electrical current to stimulate muscles and nerves that are no longer able to be controlled by an individual. Nodes are placed on nerve and muscle areas that are damaged and the electrical current produces movement. Over time the patient will have the ability to reproduce this movement of their own volition.

I. INTRODUCTION

FUNCTIONAL electrical stimulation is a method of reactivating muscles and nerves that can be helpful for many individuals across a wide span of disabilities such as urinary incontinence, lack of upper limb control, spinal cord injuries, head injuries, cerebral palsy, multiple sclerosis, paraplegia and quadriplegia. FES occurs by placing nodes on a patient’s skin where the muscles and nerves that are to be stimulated are located. For instance, the peripheral nerve can be stimulated to produce movement in the arms and legs. The electrical current sent out from these nodes stimulates the lower motor neurons that connect the spinal cord to the muscles which will then in turn create patterned movement of the limbs. The individuals will be told to imagine the sensation of their limbs moving while the movement created by the stimulation is occurring which leads to retraining the central nervous system and helps the patient regain muscle control. Since there is such a large range of applications of FES, the focus of this paper will be on upper limb motor recovery. Upper limb motor recovery is necessary in individuals that have gone through a stroke and has been used with great success in restoring function and providing an individual with the ability to continue on living a normal life.

II. METHODS

After a stroke, an individual often loses control of many of their muscles and nerves. In some cases, over time an individual can regain control of these muscles through physical therapy and persistence. With the use of functional electrical stimulation devices and therapist assistance, individuals can gain muscle control back that they would otherwise not regain. An example of a FES device can be seen in the image below.

The patches are attached the patients skin where the muscles are located and on the left side of the picture is the trigger that is controlled by the therapist to create the patterned movements in succession.

When a patient is being treated for upper arm recovery the nodes are placed on the anterior and posterior deltoid, biceps and triceps brachialis, flexor carpi radialis, flexor carpi ulnaris, extensor carpi radialis, and extensor carpi ulnaris. Using symmetrical biphasic current pulses, a pulse duration of 250 microseconds, and a constant stimulation frequency of 40 Hz, the arm is able to swing forward, touch the nose, or swing up. Recreating these muscle movements allow the individual to retrain their muscles and nerves to create the movement and feel the sensations so that they are able to perform these actions on their own.

III. RESULTS

Over 12 weeks of FES, an individual who was previously unable to draw circles due to the elbow and shoulder coordination requirements to do so and lack thereof, can now draw small and large circles as well as pick up thin objects, and touch their own nose. Due to the recreation of these movements with the electrical currents the patient is able to recreate these movements of their own volition.

IV. DISCUSSION

It is clear that FES is a great help for many individuals who have lost control of their muscles. There are many advantages to this therapy due to the fact that it is a noninvasive device and helps so many people across such a large range of disabilities. Also, FES devices can cost as low as $5,000 dollars and the therapy sessions are also covered by insurance. At the same time, there are also some disadvantages such as pain and skin irritation at the node placement site and the muscles get tired rapidly due to the frequency required to create action potential. The therapist will then increase the frequency required to battle the muscle fatigue which will create fatigue at an even more rapid pace. Therefore, it is extremely important to optimize the simulation strategy so that the pace is set to not overtire the muscles and is spaced out to two one hour sessions per day which will provide proper time for recovery as well as enough time for effective stimulation to take place.

Overall, functional electrical stimulation is a great process which produces contractions in muscles and movements in individuals who can’t control their own muscles anymore. It provides individuals with a chance to move their own arms and legs again which is invaluable. With the improvement in technology even more areas of the body will be able to be stimulated and the use of FES will continue to grow and help even more people live life every day without the need of assistance.

REFERENCES

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