Ankle Foot Orthotic

Midsemester Report

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Abstract

In the beginning of the semester, our client, Dr. Robert Przybelski, was urged to propose the active ankle/foot orthotic project at the request of one of his patients. His patient, suffering from a medical condition known as foot drop, was very dissatisfied with the orthotic she was currently using and was hopeful that our design team could improve upon it. The orthotic she used only addressed the basic problems associated with foot drop, such as supporting ankle weakness and holding the foot at a fixed position of 90 degrees to the ankle. It was also very bulky and did not easily fit in a shoe. This design only stopped the foot from "dropping" and made walking very uncomfortable and awkward. In fact, the device was so cumbersome, the patient preferred to walk without it. Leading a very active lifestyle and very interested in being able to hike, the patient was seeking an orthotic that more closely simulated a normal human gait pattern and actively enhanced the walking motion. With this is mind, it was our team's goal to design an orthotic that not only supported ankle weakness and held the foot in a fixed position, but also actively enhanced walking and improved balance and proprioception.

Background

Thousands of people worldwide are afflicted by diseases that affect their normal gait pattern. Several neuropathies that commonly cause walking abnormalities are stroke, Charcot-Marie-Tooth Disease (CMT) and multiple sclerosis (MS). Each of these diseases afflicts the patient in a different manner; stroke affects the patient by depriving the brain of essential nutrients while CMT and MS affect the peripheral nervous system.

Stroke is an illness that strikes a person when part of the brain is prevented from receiving oxygen and other essential nutrients from the bloodstream. The two primary types of stroke are ischemic and hemorrhagic stroke. Ischemic stroke occurs when a blood vessel supplying blood to the brain is blocked, suddenly disrupting the blood flow to the brain. As a result, the part of the brain being supplied by this blood vessel dies. On the other hand, hemorrhagic stroke occurs when the brain itself bleeds and blood spills into the spaces surrounding the brain cells and suffocates parts of the brain. Although the types vary in their origin, they both prevent the brain from receiving nutrients and cause part of the brain to die. Once a region of the brain dies, the body loses all functions that were controlled by that area of the brain. The severity of a stroke depends on the region of the brain that was affected as well as the size of the region that was affected. While they can range from mild to severe, the symptoms that primarily affect a normal walking pattern are partial or complete paralysis as well as problems with vision.

While stroke affects a person's ability to walk through brain death, Charcot-Marie-Tooth affects normal gait because it afflicts the peripheral nervous system. The main components of the peripheral nervous system are the nerve cells, axons, myelin sheath and muscle fibers (Appendix A, Figure 1). Normally, the nervous system relays messages between the brain and muscle fibers via electrical signals through the axons. The axon is surrounded by myelin, which is responsible for insulating the axons from the surrounding cells. By acting as an insulator, the myelin protects the structure of the axon and prevents the electrical signal from dissipating as it travels further distances.