Developments in Spine Therapy Helping Paralyzed Patients Walk Again
Tanvee Sinha

Most spinal cord injuries have an almost immediate and devastating effect on the person’s motor control. These severe impairments result from the interrupted communication between the brain and spinal cord, which deprives the spinal cord below the injury of instructions from the higher-level executive functions in the body. Without the essential sources of direction and excitement from the brain, the parts coordinated below the injury on the spinal cord face severe motor deficits – often complete or partial paralysis.

Epidural electrical stimulation (EES) enables coordination from the executive centers to aid in promoting basic movements and potentially complex motions like walking. In some rodent, feline, and nonhuman primate models of leg paralysis, researchers were able to restore the ability to walk using the EES technique. EES is not a new solution for paralysis patients but is not commonly used, as it has previously shown to be less effective when applied to the human spinal cord. Human neural networks have characteristics that make the process more complex. The results in rats suggested that EES parameters such as stimulation time, location, and types of therapy would have to be extremely specific in order to enhance the excitability of the spinal cord without affecting other neural information regarding physical movements.

According to an October 2018 study led by Grégoire Courtine, a neuroengineer at the Swiss Federal Institute of Technology in Lausanne, EES coupled with therapy and training have helped three human paralysis patients successfully walk with varying degrees of support. These three patients were all paralyzed from an injury over four years earlier and hadn’t regained movement until the study, even with extensive rehabilitation. Most of the rehab that they had gone through included solely focusing on the physical movements of flexing and pointing different leg muscles to strengthen them again, rather than checking for existing connections in the spine and stimulating them to relay information.

In this study performed by Courtine and his team, certain patterns of stimulation for the spinal cord in injured areas re-established previously broken neural connections and helped trigger certain movements. Some of these movements could include lifting a leg versus setting it down, as one would do in basic rehabilitative therapy.

To better control the timed therapy coupled with electrical stimulation on the spinal cord, Courtine’s team designed and developed a wireless device to control the stimulator and make it deliver targeted pulses of electricity to certain neurons at specific times along with certain movements. They chose to do targeted pulses over constant stimulation, as constant stimulation doesn’t allow the patient to feel their limb in space. Consciously acknowledging the action and getting a feel for their movement is imperative in order to perform complex coordinated movements.

Patients wore the wireless device along with a harness that helped support their body weight. With this setup, the three patients walked in therapy while receiving the stimulation. Within five months, two patients walked hands-free with only 35% of their body weight supported by the harness. The last patient had more severe injuries and therefore a longer recovery process.

Overall, the three patients all regained the ability to make small movements, with little to no dependence on the electrical stimulations. The two patients with less severe injuries moved from sitting to standing and were able to walk short distances with crutches. The third patient recovered significantly slower, so in the same time span, he could voluntarily move his legs but was not at the same level of control as the other two patients were.

This achievement of helping patients gain mobility after paralysis has inched researchers closer to restoring movement for paraplegic people. These same results were present in another study with patient Jared Chinnock, a 29-year-old male who was left paralyzed below the chest from a snowmobile wreck. In his case, after two weeks of stimulation and therapy, he could stand, and while lying on his side, make voluntary step-like movements. Eventually, he gained the ability to take strides on a treadmill and could take more coordinated steps on his own, showing significant improvement from his basic paralysis.

While these results are encouraging, applications of spine
therapy in paralyzed patients remain at very early stages in research. Successes with these few teams have raised a number of questions, including whether a similar approach would work for patients with other types of spine damage. For the approach itself, researchers need to work on being able to pinpoint the movements that are more or less beneficial to make the therapy protocol less rigorous for the patients as well as more efficient. In addition, research teams generally agree that this therapy would have greater success if started earlier. All of these questions and points lead to further discussion about this approach to spine therapy and possible improvements for it in the future.