Carmel Laboratory Update

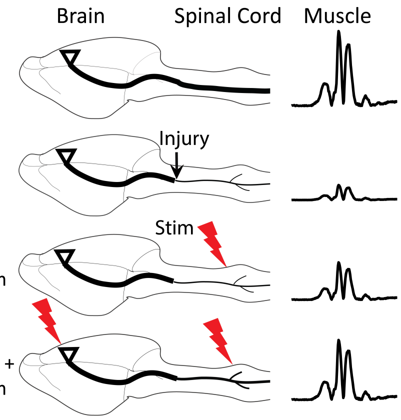
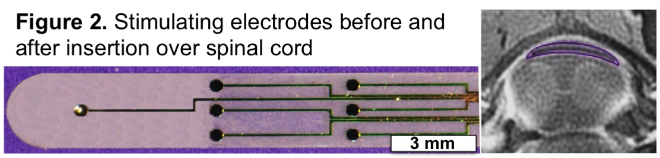


Figure 1. Expected Results

The goal of our laboratory is to improve arm and hand function in people living with paralysis. With generous support from the Travis Roy Foundation, we have made significant progress towards this goal. Our approach has been to use electrical stimulation to strengthen connections between the brain and spinal cord (Figure 1). Injury to the spinal cord in the neck disrupts the nerve fiber connections between the brain and the parts of the spinal cord that control arm and hand movements. However, most injuries spare some of these connections, even in people with no movement below the site of injury. By pairing brain and spinal cord stimulation, we can create stronger brain-spinal cord connections in rats. This is true at the time that spinal cord stimulation is given. But, importantly, this also occurs after the stimulation has ended; like the brain, the spinal cord can learn. Thus, we are able change the connections between the brain and spinal cord in a lasting way in lab rats using electrical stimulation.

Figure 2. Stimulating electrodes before and after insertion over spinal cord



The next step in our studies is to test whether pairing brain and spinal cord stimulation can improve function in rats with paralysis. A critical advance has been development of a device to chronically stimulate the cervical spinal cord. To perform stimulation, we insert an electrode into the narrow space between the cervical spinal cord and the overlying bone. To insert the electrode, it needs to be thin and relatively stiff. However, the neck moves over a large range and in many directions. Thus, the electrode should be supple. To do this, we partnered with biomedical engineers to produce very thin electrodes that cover the cervical spinal cord (Pictured in Figure 2). In addition to being 1/20th of a millimeter thick, these devices have the remarkable property of softening when they are in the warm body environment. This makes them extremely supple and safe. Indeed, they take the shape of the underlying spinal cord, as shown in the MRI image on the right of Figure 2. These devices are effective out to 5 months and counting. This allows us to test whether pairing brain and spinal cord stimulation over days to weeks can restore connections and improve function after spinal cord injury.

Although we are still testing in rats, we have used methods that can be quickly tested in people with cervical spinal cord injury, whose top goal is recovery of arm and hand function. Over 50,000 people in the United States have epidural spinal stimulating electrodes implanted for pain. Since we propose to compare our new stimulating devices against those that are already FDA-approved, this approach could be adopted quickly if it is proven effective in the laboratory. Devices currently used have some complications, such as moving away from the intended location or breaking of connections where they enter the spinal canal. The new devices address these concerns and will likely improve the current technology, which has remained largely unchanged since the 1980’s. Thus, we are performing the necessary experiments in rats to determine whether our approach is safe and effective, but with the goal of using the technology to improve the lives of people living with spinal cord injury.