Spinal Cord Injuries

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Spinal cord injury (SCI) is perhaps one of the worst injuries known to occur. Nearly 5000 years ago the ancient Egyptians determined this to be "an ailment not to be treated". Today approximately 10,000 spinal cord injuries occur each year. Males are four times as likely and tend to be in the 16-30 year old age group. The annual cost to the nation is estimated to be more than $6 billion. Nationwide motor vehicle accidents are the most common cause and increasing the likelihood of paralysis are a lack of seat belt usage and an association with alcohol intoxication. Celebrities such as actor Christopher Reeve and the late Kansas City Chief Derrick Thomas have heightened public awareness of SCI casting national attention on therapies and the search for a cure.

Rarely in any case is the spinal cord torn in half. Typically what occurs is a fracture or dislocation of the spinal column bruising the spinal cord located within the spinal column. This is known as the *primary injury* and can only be reversed with prevention of the accident. Once injured this sets forth a cascade of events known as the *secondary injury*. It is during this phase that the spinal cord begins to swell. The body attempts to repair and remove the damaged tissue but in doing so causes irreversible damage to the spinal nerves. The end result is scar tissue in an area once rich with nerve tissue. In adults the body has very limited capacity for nerve regeneration resulting in a loss of functional neural circuits. Therefore, therapeutic strategies after SCI are directed at preventing or decreasing the secondary injury and restorative or regenerative interventions.

Methylprednisolone is the first drug proven to change the outcome after SCI. This drug seems to decrease swelling in the cord and also preserves the structure of the nerve tissue preventing the destruction of nerve cells and *axons* (nerve highways). Studies verified improvement in motor and sensation function when given within 8 hours of injury. However, the amount of motor improvement is quite small. Most patients are treated for 24–48 hours. Various other drugs have been studied attempting to halt the cascade of destruction at various points of the chain but have not demonstrated any significant improvements thus far.

The most promising of therapies are directed to the regeneration of nerve tissue at the site of injury. This can be achieved in two ways: by stimulation of growth of existing nerves at the site of injury or by transplanting normal nerve tissue to the scarred area. The goal of this treatment is the bridging of axons across the injury and the restoration of ascending and descending pathways.

Growth factors (neurotrophins) have been shown to improve motor function in animals although no human studies have been done. These compounds can stimulate nerve growth as well as the formation of *myelin*, which insulates the axons and allows for impulse transmission. This effectively allows for reorganization of the injured area.

Tissue transplantation can provide for a "cellular bridge" filling in the injured area and provides chemical and mechanical cues for repair. It provides for new neurons and it can provide a variety of

substances that may help with the repair process. Not only can blocks of tissue be used such as is done with *fetal cell* transplants but specific cells such as *stem cells, olfactory ensheathing cells*, and *Schwann cells* can be isolated and then transplanted. Fetal cells have been used for Parkinson's disease and in the spinal cord can bridge damaged axons. A problem with this technique or any other regeneration technique is the inability to control target specific interactions resulting in the improper crossing of pathways. Additional concerns include the ability to be able to turn off the regrowth phenomenon so as to not get out of hand like a cancerous growth. These therapies still need extensive study before applications in human studies begin.

Clearly there is hope for cure of paralysis in the future although no timetable exists for this in the foreseeable future. Much more investigative work is needed in laboratory and animal studies before human trials can begin. At this point in time prevention is still the best remedy.