Establishing Reconstructive Neurosurgery as a Subspecialty

My name is Justin Brown and I'm the co-director of the UCSD Paralysis Center and lead author of the paper, Establishing Reconstructive Neurosurgery as a Subspecialty. This article is a part of the July 2017 edition of neurosurgical focus entitled, Neurosurgical Rehabilitation: Restorative functional and Reconstructive Neurosurgery.

Modern medicine has evolved to such a degree that we are now able to halt the progression of devastating neurological diseases and save the lives of those suffering the severest of neurological injuries.

While lives are saved, quality of life at times suffers dramatically. Techniques are available today to restore a significant degree of function to patients suffering from almost any paralyzing injury.

Once we have addressed the source, we need to determine whether the predominant type of weakness is of upper or lower motor neuron origin. This is critical as these types of paralysis are managed very differently.

In managing lower motor neuron disorders, function of the original muscles can only be restored by regrowth of axons back to those denervated muscles. For example, this young man suffered an injury affecting the musculocutaneous nerve in the posterior cord of the brachial plexus.

He underwent fascicular transfers from median and ulnar nerves to the musculocutaneous nerve branches which innervate the biceps and brachialis muscles. He also underwent transfer of the lower subscapular nerve to the long head of triceps branch of the radial nerve.

He recovered good strength of both these muscle groups and antigravity function at three months. He went on to essentially full recovery by a year.

When the injury is predominantly of upper motor neuron source, reconstruction is undertaken after a significant delay following injury. When a functional plateau has been reached, there are a number of interventions that may optimize the new functional status.

Prior to proceeding, it’s important to ensure that the patient has received appropriate therapy and has been compliant with that therapy.

This is a 30-year-old female who presented three years after falling down a staircase resulting in a c5 ASIA A spinal cord injury. As is typical for a c5 injury, she was found to have good control of external rotators of the shoulder and paralyzed yet innervated triceps as determined by electro diagnostic studies.

Such upper motor neuron paralysis preserves the paralyzed muscles such as the nerve transfer can be undertaken in the chronic period after the onset of paralysis. She underwent an axillary to radial nerve transfer using the teres minor branch of the axillary nerve transferred to reinnervate the triceps branch of the radial nerve.

She secondarily underwent a brachialis branch of the musculocutaneous nerve transfer via a sural nerve graft to the anterior interosseous nerve. When addressing primarily spastic patients, whether hemiplegic from stroke or traumatic brain injury or quadriplegic from spinal cord injury or traumatic brain injury, it should be understood that spasticity often conceals neighboring muscles with functional control.

While some details on motor control of the limb can be determined through a detailed physical examination, much cannot. Multichannel functional EMG provides the best information regarding the underlying motor control.

This is a 53-year-old who was in a dirt bike accident and suffered upper cervical fracture dislocation resulting in c4 ASIA D spinal cord injury. He was stabilized and recovered significant strength, but persistent left-sided spasticity severely limited his function. In particular, he could not reach his mouth with his functional biceps as a result of the severe spasticity of his triceps.

He, therefore, underwent neurotomy of the radial nerve branches to the triceps. Just as vascular neurosurgery has been advanced by adopting endovascular techniques formerly performed by interventional neuroradiologists, and spine surgery has advanced dramatically by the incorporation of instrumentation techniques formerly attributed to orthopedics, reconstructive neurosurgery has required adoption of a set of procedures not formally considered central to neurosurgery in order to achieve the best results.

This is a 33-year-old gentleman who suffered a mid-cervical fracture during a high school football game. This left him in ASIA A c5 complete spinal cord injury, with paralysis primarily of upper motor neuron source.

He presented 12 years after his injury, a strong elbow flexion and a weak wrist extension, but no function of his hands or fingers. He underwent a supinator branch of the radial nerve transfer to the posterior interosseous nerve and a brachialis branch of the musculocutaneous nerve transfer via graft to the interior interosseous nerve.

He additionally underwent a thumb fusion to position it in both supination and palmar opposition and finally a brachioradialis to flexor pollicis longus tendon transfer, giving him independence of thumb flexion versus the nerve transfer driven finger flexion.

For ambulatory but spastic patients, the tibial neurotomy has been found to improve foot position and walking endurance. In this procedure, branches of a tibial nerve that innervate the gastrocnemius, soleus, tibialis posterior, and toe flexors are trimmed based on the relative contribution to the dysfunction.

When the excessive inversion does not correct, a split tibialis anterior tendon transfer can augment the effect of this neurotomy procedure by balancing the newly acquired dorsiflexion and prevent inversion.

Following this intervention, potential for graduation from the AFO brace is notably improved. In conclusion, the number of weakness in paralysis cases generated in a single medical center is more than enough to keep a reconstructive neurosurgeon or even a team of reconstructive surgeons quite busy but the practice is limited to functional reconstruction.

The field is ripe for development, given our advances in diagnostic modalities, particularly that of neurophysiological techniques, our recent advances and available reconstructive options, and the great number of research programs focusing on bringing additional modalities to the clinical setting.

It is time for reconstructive neurosurgery to find its place amongst the primary neurosurgical subspecialties and for residents to be exposed to these concepts as a part of their neurosurgical training.