



## Neurotrauma as an Evolving Indication for Neuromodulation

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Trauma is a major cause of morbidity and mortality in developing countries. With the advent of life-saving procedures and better inpatient care in trauma-specialized centers in our country, more and more patients are getting their lives back although with residual handicaps, disabilities and pain. Specific therapies must be used to increase quality of life and decrease pain and sufferings in trauma patients, when most of them are young and in their productive ages. Ablative neurosurgical procedures have been used in the past to treat different neurological diseases with significant irreversible side effects. They were useful in controlling pain or improving abnormal movements or behaviors in patients. Recently, many, albeit not all ablative surgeries have been replaced by neuro-stimulative technologies, which can produce the same effects but reversibly, so unwanted complications may be avoided.

Neuromodulation refers to a specific subgroup of minimally invasive procedures aiming to provide therapeutic electrical stimulation to a predesigned field of the nervous system, so the whole system may work more efficiently to reduce pain and movement disorders, and to improve quality of life [1]. Among minimally-invasive procedures, different techniques exist, including deep brain, spinal cord, peripheral

nerve and sacral nerve stimulation procedures. Trauma patients have not been an ideal indication for most of these procedures; however, with the advent of newer generation of technologies, trauma is now trying to be re-considered as an evolving indication. Since 2014 we have started different techniques of neuromodulation in Shiraz for various indications. Due to the high rate of trauma patients in the region, traumatic brain and spinal cord injuries are being considered as common indications in our center.

### *Deep Brain Stimulation (DBS)*

DBS is commonly used in patients with movement disorders (mainly Parkinson's disease, dystonia and tremor) and psychiatric indications. Early reports from the positive effect of deep brain stimulation on patients suffering from severe traumatic brain injury [2] have been promising, and the first prospective study of DBS in these patients has proven its safety and potential effectiveness for functional independence in future [3]. More clinical research is necessary to bring DBS into clinical practice for trauma patients.

### *Spinal Cord Stimulation (SCS)*

Spinal cord or dorsal column stimulation has been used in a variety of different neurological conditions

for over 40 years. It is now FDA-approved for treatment of chronic neuropathic pain of the trunk and limbs, mainly causalgias and complex regional pain syndrome, failed back surgery syndrome, and angina pectoris [4]. Currently in our center, we have focused on these indications, as well as trauma indications including traumatic causalgias, painful traumatic neuropathies, failed back surgery syndrome following spinal trauma, and spinal cord injury pain. Interestingly, extensive research is being carried out internationally on improving leg movements after spinal cord injury using SCS [5].

### Neuromodulation for Epilepsy

Post-traumatic epilepsy is a major challenge for patient with brain injury, and one-third of these patients will become refractory to medical treatment [6, 7]. Trauma patients are also poor candidates for classic ablative epilepsy surgeries [6, 7]. Neurostimulation techniques including deep brain stimulation and vagal nerve stimulation offer significant reduction of epileptic attacks in selected patients [8].

### Intrathecal Pumps

As a chemical form of neuromodulation, programmable intrathecal pumps offer significant clinical improvement to patients with spasticity

(baclofen) or neuropathic pain (opioids or clonidine) following trauma. There is evidence that intrathecal baclofen pump is an effective treatment for managing spasticity in patients with spinal cord injury or severe head trauma [9].

### Sacral Neuromodulation (SNM)

Sacral nerve stimulation or SNM, along with percutaneous tibial nerve stimulation (PTNS) are becoming well-established treatments for patients with lower urinary tract dysfunction, as well as fecal incontinence. The applicability of these techniques to neurogenic causes of incontinence was first doubted because of the lack of an intact neural arch; however, some trials have recently shown benefit in this subgroup of patients as well [10]. In our small but growing series, we have focused on patients with traumatic spinal cord injury, and early results are promising [11].

In conclusion, neurotrauma is becoming an interesting and more common indication for neuromodulation. Careful patient selection, in addition to the establishment of a multi-disciplinary approach will result in better efficacy and outcome in this population of patients.

**Conflict of Interest:** None declared.

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