INTRODUCTION

Neurorestoration: re-animating the CNS

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Loss of neurological function occurs naturally with aging, with degenerative conditions such as Parkinson's disease and dementias, and with acquired conditions such as stroke, traumatic brain injury, and neoplasms of the nervous system. In recent years, there has been growing interest in developing technologies aimed at restoring function to the nervous system after degeneration or injury.

Conventional strategies to promote neuroregeneration and recovery involve the delivery of biological payloads such as gene therapy and stem cells. Although these efforts to explore conventional strategies continue to show promise, neuromodulation and neuroprosthetics technologies and their clinical applications are evolving rapidly, providing numerous potential parallel and adjunctive approaches to facilitate neurorestoration.

In this issue of *Neurosurgical Focus*, a collection of articles is presented to highlight novel developments in the neurorestoration. The potential for neurorestoration after stroke is discussed, centering on a disease well recognized for producing a significant burden of disability worldwide. The concept is then expanded to include neurological functional loss occurring as a byproduct of our treatment of diseases, such as radiation treatment of cancers in and of the central nervous system. Neuromodulation strategies such as cortical stimulation, deep brain stimulation, and

spinal cord stimulation have conventionally been focused on motor dysfunction and chronic pain. While these treatments have documented efficacy, efforts to further refine these approaches remain extremely important, as do new areas of exploration and technology development to address loss of cognitive dysfunction, such as memory. In addition, considerable ongoing research endeavors to identify new ways to extract electrophysiological information from the brain and then apply modulation. This represents the two halves of the neuroprosthetics paradigm. Conventionally, neuromodulation extracts information and delivers modulation electrically via penetrating electrodes. The limitations to this approach are well-described. As an alternative, recording electrodes can be delivered to relevant brain regions by way of naturally existing networks of blood vessels. Finally, optogenetics has emerged to allow neuromodulation of brain function using light. Taken together, these developments are greatly expanding the possibility that neurological function can indeed be restored after injury, disease, or normal aging.

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Disclosures

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