Spinal cord injury treatment

see Spinal cord injury management.

There are currently no effective therapies available to ameliorate loss of function available for spinal cord injury. In addition, proposed treatments which demonstrated functional recovery in animal models of acute spinal cord injury (SCI) have almost invariably failed when applied to chronic injury models. Glial scar formation in chronic injury is a likely contributor to limitation on regeneration.

Substantial heterogeneity in the patient population, their presentation and underlying pathophysiology has sparked debates along the care spectrum from initial assessment to definitive treatment.

In seeking a cure, these patients often undergo treatments that lack scientific and methodological rigor.

Ahuja et al. reviews spinal cord injury (SCI) management followed by a discussion of the salient controversies in the field. Current care practices modeled on the American Association of Neurological Surgeons/Congress of Neurological Surgeons joint section guidelines are highlighted including key recommendations regarding immobilization, avoidance of hypotension, early International Standards for Neurological Classification of SCI examination and intensive care unit treatment. From a diagnostic perspective, the evolving roles of CT, MRI, and leading-edge microstructural MRI techniques are discussed with descriptions of the relevant clinical literature for each. Controversies in management relevant to clinicians including the timing of surgical decompression, methylprednisolone administration, blood pressure augmentation, intraoperative electrophysiological monitoring, and the role of surgery in central cord syndrome and pediatric SCI are also covered in detail. Finally, the article concludes with a reflection on clinical trial design tailored to the heterogeneous population of individuals with SCI [1].

Cell therapy

see Spinal cord injury stem cell therapy.

Perfusion

Increased spinal cord perfusion and blood pressure goals have been recommended for spinal cord injury (SCI).

Treatment consists of restoration of CSF flow, typically via arachnoidolysis and syrinx decompression Research into treatments for spinal cord injuries includes controlled hypothermia and stem cells, though many treatments have not been studied thoroughly and very little new research has been implemented in standard care.

Treatment of spinal cord injuries starts with restraining the spine and controlling inflammation to prevent further damage. The actual treatment can vary widely depending on the location and extent of the injury.

Acute spinal cord injury (SCI) is commonly treated by elevating the mean arterial pressure (MAP). Other potential interventions include cerebrospinal fluid drainage (CSFD).

Both MAP elevation alone and CSFD alone led to only short-term improvement of SCBF. The combination of MAP elevation and CSFD significantly and sustainably improved SCBF and spinal cord perfusion pressure. Although laser Doppler flowmetry can provide flow measurements to a tissue depth of only 1.5 mm, these results may represent pattern of blood flow changes in the entire spinal cord after injury [2].

Lumbar cerebrospinal fluid drainage after spinal cord injury, as used in the pig study by Martirosyan et al would reduce intrathecal pressure at the injury site only if the spinal cord is not compressed against the surrounding dura. Unfortunately, in most patients with severe spinal cord injury, the spinal cord is compressed against the surrounding dura; therefore, drainage of cerebrospinal fluid from the lumbar region will not reduce intrathecal pressure at the injury site [3].

Unfortunately, no data correlate the severity of spinal cord injury, the degree of spinal cord swelling, and persistent CSF flow across an injured segment in the human spinal cord. The physiological observations in animals and humans alike indicate that CSF drainage and induced hypertension warrant further investigation as a potential treatment for acute spinal cord injury [4].

Rehabilitation

In many cases, spinal cord injuries require substantial physical therapy and rehabilitation, especially if the patient's injury interferes with activities of daily life.

Pharmacological Therapy

Despite a degree of theoretical progress, there is a lack of effective drugs that are able to improve the motor function of patients following spinal cord injury (SCI) [5] [6] [7] [8].

see Methylprednisolone for Spinal cord injury.

Dexamethasone acetate (DA) produces neuroprotective effects by inhibiting lipid peroxidation and inflammation by reducing cytokine release and expression. However, its clinical application is limited by its hydrophobicity, low biocompatibility and numerous side effects when using large dosage. Therefore, improving DA's water solubility, biocompatibility and reducing its side effects are important goals that will improve its clinical utility. The objective of this study is to use a biodegradable polymer as the delivery vehicle for DA to achieve the synergism between inhibiting lipid peroxidation and inflammation effects of the hydrophobic-loaded drugs and the amphipathic delivery vehicle. Wang et al., successfully prepared DA-loaded polymeric micelles (DA/MPEG-PCL micelles) with monodispersed and approximately 25 nm in diameter, and released DA over an extended period in vitro. Additionally, in the hemisection spinal cord injury (SCI) model, DA micelles were more effective in promoting hindlimb functional recover, reducing glial scar and cyst formation in injured site, decreasing neuron lose and promoting axon regeneration. Therefore, data suggest that DA/MPEG-PCL micelles have the potential to be applied clinically in SCI therapy [9].

Surgery

After traumatic spinal cord injury (TSCI), laminectomy does not improve intraspinal pressure (ISP), spinal cord perfusion pressure (SCPP) or the vascular pressure reactivity index (sPRx) at the injury site sufficiently because of dural compression.

21 patients with acute, severe TSCI had realignment of the fracture and surgical fixation; 11 had laminectomy (laminectomy group) and 10 had laminectomy and duroplasty (laminectomy + duroplasty group). Primary outcomes were MRI evidence of spinal cord decompression (increase in

intradural space, cerebrospinal fluid around the injured cord) and spinal cord physiology (ISP, SCPP, sPRx). The laminectomy and laminectomy + duroplasty groups were well matched. Compared with the laminectomy group, the laminectomy + duroplasty group had greater increase in intradural space at the injury site and more effective decompression of the injured cord. In the laminectomy + duroplasty group, ISP was lower, SCPP higher and sPRx lower, i.e. improved vascular pressure reactivity, compared with the laminectomy group. Duroplasty caused cerebrospinal fluid leak that settled with lumbar drain in one patient and pseudomeningocele that resolved in five patients. We conclude that, after TSCI, laminectomy + duroplasty improves spinal cord radiological and physiological parameters more effectively than laminectomy [10].

Internal decompression

Refers to pial opening, allowing spontaneous extrusion and irrigation of fluid necrotic debris relieving pressure and resulting in a space for biomaterial scaffold insertion. After thoracic contusions, rats were randomized to: contusion only, contusion + ID and contusion + ID + PLGA-PLL scaffold implantation, to test for neuroprotection and endogenous repair over 3 months. ID alone reduced inflammatory activity, cavity volume, and increased tissue sparing. Scaffold biodegradation produced delayed ingrowth of inflammatory and other cells resulting in endogenously derived laminin-rich tissue, marked reduction in cavitation and presence of tissue remodeling macrophages. Extensive recruitment of Schwann cells into adjacent spared white matter occurred, greatest in scaffold-implanted animals. Despite tissue preservation with myelin repair, no groups differed significantly in open field locomotion. However, across all rats, spared epicenter tissue and locomotor outcomes were correlated. Scaffold-implanted animals showed no obvious toxicity. To study the clinical feasibility, timing and indications for scaffold implantation, Göttingen minipigs underwent ID and were implanted with scaffolds 4, 6, and 24 h after T10 contusion. High intra-spinal tissue pressures fell to pre-injury levels after ID and scaffold implantation. Extrusion of necrotic debris left sufficient space for a sized scaffold. These results provided the preclinical rationale for a current clinical study of biomaterial scaffold implantation into the human injured spinal cord [11].

Near-infrared light-triggered NO release

Jiang et al. suggested a “pleiotropic messenger” strategy based on near-infrared (NIR)-triggered on-demand NO release at the lesion area for traumatic SCI recovery via the concurrent neuroregeneration and neuroprotection processing. This NO delivery system was constructed as upconversion nanoparticle (UCNP) core coated by zeolitic imidazolate framework-8 (ZIF-8) with NO donor (CysNO). This combined strategy substantial promotes the repair of SCI in vertebrates, ascribable to the pleiotropic effects of NO including the suppression of gliosis and inflammation, the promotion of neuroregeneration, and the protection of neurons from apoptosis, which opens intriguing perspectives not only in nerve repair but also in neurological research and tissue engineering [12].

Experimental spinal cord injury treatment

Experimental spinal cord injury treatment

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