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Commentary

Biomedical Techniques for Neural Tissue Regeneration

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DESCRIPTION

Neural tissue regeneration, also known as neuro regeneration, seeks to restore function to neurons that have been damaged in minor and major injuries, such as those caused by traumatic brain injury. The re-establishment of a continuous pathway for regenerating axons to the site of innervation is required for the functional restoration of damaged nerves. Tissue engineering strategies treatments for repair and regeneration after traumatic brain injury and spinal cord injury. Investigating methods that combine neural stem cells with an extracellular matrix protein-based scaffold for minimally invasive delivery into irregularly shaped lesions that form after a traumatic insult.

Small gaps can be repaired with autologous nerve grafts by end-to-end surgical sutures of damaged nerve ends. For larger injuries, an autologous nerve graft harvested from another part of the body may be used, though this procedure is time-consuming, expensive, and requires two surgeries. Clinical treatment for CNS is limited and primarily focuses on reducing collateral damage caused by bone fragments close to the site of injury or inflammation. After the swelling around the injury has subsided, patients are rehabilitated so that the remaining nerves can be trained to compensate for the loss of function in injured nerves.

Biomedical strategies for regeneration of neural tissue

Biomedical strategies for spinal cord injury repair are centered on creating a favorable environment for nerve regeneration. So far, only PNS nerve damage has been clinically possible, but advances in genetic techniques and biomaterials research show that spinal cord nerves can regenerate in permissible environments.

Grafts: Autologous tissue grafts have the advantage of being made from natural materials, which have a high likelihood of biocompatibility, providing structural support to nerves, which encourages cell adhesion and migration. Nonautologous tissue, acellular grafts, and extracellular matrix-based materials are all possibilities for nerve regeneration. Some are derived from allogenic or xenogenic tissues and must be combined with immuno suppressive drugs. Others include amniotic tissue graftsand small intestinal submucosa grafts. Synthetic materials are appealing because their physical and chemical properties are typically controllable. Biocompatibility is still a problem with synthetic materials. Methylcellulose-based constructs have been demonstrated to be a biocompatible option for this application.

Nerve guidance channels: Nerve guidance channels and Nerve guidance are innovative strategies that focus on larger defects and provide a sprouting axons directing growth and reducing scar tissue growth inhibition. Nerve guidance channels must be easily formed into the desired dimensions, sterilizable, tear resistant, and simple to handle and suture. They should ideally degrade over time with nerve regeneration, be pliable and semipermeable, retain their shape, and have a smooth inner wall similar to that of a real nerve.

Biomolecular therapies: To promote neural regeneration, highly controlled delivery systems are required. Neurotrophic factors have the ability to affect development, survival, outgrowth, and branching. Nerve Ggrowth Factor (NGF), Brain Derived Neurotrophic Factor (BDNF), Nneurotrophin-3 (NT-3) and Neurotrophin-4/5 (NT-4/5) are all neurotrophins. Other factors that promote a variety of neural responses include Ciliary Neurotrophic Factor (CNTF), Glial Cell line-derived growth factor, and acidic and basic Fibroblast Growth Factors (aFGF, bFGF). Other therapies are investigating nerve regeneration by increasing the expression of Regeneration Associated Genes (RAGs), neuronal cytoskeletal components, and anti-apoptosis factors. GAP-43 and Cap-23 are RAGs, as are adhesion molecules such as the L1 family, NCAM, and N-cadherin. Because of glial scarring, there is also the possibility of blocking inhibitory biomolecules in the CNS. Treatments with chondroitinase ABC and blocking NgR, ADP-ribose are currently being researched.

Delivery techniques: Biocompatible and *in vivo* stable delivery devices are required. Osmotic pumps, silicone reservoirs, polymer matrices, and microspheres are a few examples. Gene therapy techniques have also been investigated to provide long-term growth factor production and could be delivered using viral or non-viral vectors such as lipoplexes. Cells can also transport ECM components, neurotrophic factors, and cell adhesionmolecules. Olfactory Ensheathing Cells (OECs), stem cells, and genetically modified cells have all been used as nerve regeneration transplants.

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