EDITORIAL

Bioadaptable nerve implants for peripheral nerve regeneration

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Among the treatments of peripheral nerve injuries, nerve scaffolds have emerged as an effective alternative to autologous nerve grafts. The translation of nerve scaffolds from benches to the clinic has met with a certain degree of success. Although neural-supporting scaffolds have been extensively increased and refined over the last decades, the physicochemical modifications and topography design are far from optimal.

The research topic of bioadaptable nerve implants for peripheral nerve regeneration focuses on the bioadaptablity of various nerve conduits to the peripheral nerve microenvironment and their potential uses for nerve repair. More than 1,000 publications have contributed to the current research topic, which examines from different angles the bioadaptable design for nerve-repairing scaffolds. These publications have reported (i) key cellular players and critical events that orchestrate the progression of nerve regeneration, (ii) underlying mechanisms and pathways that are activated or blocked during this process, and (iii) how functionalized nerve implants support successful peripheral nerve recovery. Herein, we are delighted to add this Editorial on bioadaptable nerve implants for peripheral nerve regeneration to the American Journal of translational medicine. We will introduce several representative review articles that have comprehensively discussed the bioadaptability of nerve implants for the reconstruction of the nerve microenvironment. A collective overview of these publications will add insights into scaffold-mediated nerve regeneration and provide theoretical support worth considering in neural engineering research.

Yan et al. (2022) analyzed current manufacturing technologies for nerve guidance conduits. Natural and synthetic materials could be processed into nerve conduits by a plethora of technologies, including extrusion-based fabrication, laser-based fabrication, and textile fabricating techniques in the form of weaving, knitting, braiding, and electrospinning techniques. These advanced fabricating technologies aim to acquire better biomechanical properties, chemical stability, and biocompatibility.

Gu et al. (2014) first brought up their leading opinions on the optimizing means of nerve scaffold design, including support cells, growth factors and cytokines, electrical stimulation, RNA interference, and neural scaffold configuration. They found that the lack of proximity to the nerve microenvironment limited the translation of innovative neural tissue engineering strategies into the clinic. Thus, developing functionalized scaffolds with neural adaptability would open a new door for peripheral nerve repair.

Qian et al. (2021) made a comprehensive overview of the novel biomimetic nanotechnology designs and biochemical or physicochemical modifications for the fabrication of neural-supporting scaffolds. They identified four critical microenvironmental factors that could be regulated by nerve implants, including immune response, intraneural vascularization, bioenergetic metabolism, and bioelectrical conduction. They confirmed that combined uses of electroactive nanomaterials, biochemical modification, and anisotropic scaffold topology could provide optimal scaffold design for nerve microenvironment remodeling. Understanding the bioadaptability of nerve conduits provides further insights and resolutions into the clinical translation of functionalized nerve scaffolds.

Inspired by nature, naturally occurring materials have been extensively used to develop biocompatible neural implants. Zhang et al. (2022) summarized the development of natural polymer-derived neural scaffolds with multiple architectures and the integration of exogenous biomolecules. Significantly, they proposed that natural polymer-derived nerve scaffolds could achieve sustained drug delivery to the injured site by protecting biomolecules from enzymatic degradation to prolong drug activity.

In summary, this research topic has presented a snapshot of the state of neural engineering and provided new insights into adaptable nerve implants for nerve regeneration. We hope that these publications can lead to novel innovations in biomaterial-induced nerve regeneration and improve the clinical translatability of neural implants.

Reference

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