



Chitin-Based Materials in Nerve Tissue Engineering



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Abstract

Chitin is widely distributed in nature and is often present in crustaceans' exoskeleton. Chitosan is the deacetylated derivative of chitin. Based on previous investigations, chitin-based scaffolds are reported to have beneficial effects on nerve regeneration by combination of many different substrates; bioactive molecules cell therapy can improve injured peripheral nerves. Here, we mentioned combinational therapy of chitin-based scaffolds in peripheral nerve injuries.

Keywords: Chitin; Chitosan; Nerve; Tissue engineering

Introduction

Among the polymers used to build matrices, chitosan has different properties that make it particularly interesting for nerve implantation [1]. To repair peripheral nerve injuries with neural gaps, the current standard treatment uses an autologous nerve graft to bridge the neural gap and facilitate nerve regeneration and reconnection. Engineered nerve grafts are usually composed of a neural scaffold, seeded supportive cells, and growth factors [2]. Among the various biomaterials under investigation, scaffolds made of chitin-based materials have drawn much attention [3].

Chitin-based materials and tissue engineering in nervous system

It is reported that a mixture of polyglycolic acid fibers and chitosan scaffold led to reconnection and repair of a long sciatic nerve defect in a dog model and a long median nerve defect in a clinical study [4]. Moreover, when the scaffold was transplanted with bone marrow-derived mesenchymal stem cells, a longer neural defect of up to 50mm in length was restored in a dog sciatic nerve [5].

During neuroregeneration, Schwann cell (SC) supports outgrowth of neurite by secreting neurotrophic factors, expressing neuron-specific ligands, managing outgrowth of neurite,

and generating and setting down of different components of extracellular matrix [6,7]. In fact, a chitin or chitosan-based scaffold can support attachment, migration, and proliferation of schwann cells to its bed. Also, chitosan scaffolds induce alignment of schwann cell and cause suitable direction to outgrowth of axons and avoiding formation of neuroma [6,7]. Moreover, appropriate mechanical strength to preserve the conduit space of chitosan-based scaffolds make available an advantageous microenvironment for proper alignment of schwann cells and their migration and adhesion to the scaffold, and make better the penetration of neurite-related factors [8]. The mentioned properties of Schwann cells alignment along the chitosan-scaffolds, oriented fibrous sheets were focused. In vivo, use of chitosan-based scaffolds led to dynamic out-growth of myelinated axons and, restoration of nerve function.

These outcomes showed that modified nerve guide tubes made of chitin-based materials broadly promote regeneration of neurite [9]. Preserving nerve stability under stress, and chitosan-chitosan interaction which leads to cohesive forces and chitosan-tissue attraction or adhesive forces should be noticed. To promote cohesion using covalent crosslinks between the chitosan chains [10] and to promote adhesion, application of photo-cross-linkable hydrogels and introducing bioadhesive covalent cross-links by photoactivation are suggested and have been widely noticed for

tissue engineering, wound healing, drug delivery [11]. (Meth) acrylation or conjugation with aryl azide are applied for a variety of natural and synthetic modifying and photo-cross-linking polymers. Hydrogel networks of these polymers are formed by photoactivation or reactive groups [12]. Introducing 4-azidobenzamide, a polysaccharide to chitosan, can be generated by photo cross-linking chitosan with 4-azidobenzoic acid [13]. The resultant Az-chitosan dissolves in water, generating a gelatinous solution that swiftly forms a hydrogel under ultraviolet (UV) irradiation. Gelation of Az-chitosan occurs through photolytic transformation of aryl azide to reactive nitrene, which undertakes ring extension and joining of amines to form inter- and intramolecular networks [14].

Conclusion

Chitin-based materials support neuronal growth. In addition, many different substrates and bioactive molecules have been added into chitin-based scaffold to increase their affinity with nerve cells. Therefore, a chitin-based, nerve-guiding scaffold can successfully connect long gaps and promote nerve regeneration and functional recovery.

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