Polymer-Hyaluronic Acid Scaffold for Nerve Regeneration

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Opportunity and Significance

The current problem that neural tissue engineering is facing is the use of polymers that can fit many different roles. Some studies prefer polymers such as polylactic acid or collagen. These are more biodegradable and can be combined with some conductive polymers to introduce its biodegradability property. When making a nerve conduit, most scaffolds are split into different categories – plain scaffold, scaffold that contains growth factors and scaffolds that contain some existing cells and growth factors. However, there are numerous other ways that may help promote growth that can be seen in the picture below. Recently, studies have shown that electrical stimulation does provide outward growth compared to scaffolds that did not receive the electrical stimulation.¹

Related Work and State of Practice

Currently, the gold standard in nerve repair is using autographs – using nerve from another part of the body to reconnect the damaged portion. Here at WSU, faculty have tested scaffolds (hollow tubing) with different growth factors included in them to promote growth. This project is going to use the electrical stimulation as in conjunction with scaffolds – sheets. Another method to help promote regeneration is to use nerve conduits which help connect the two nerves to promote growth in one direction. There are currently many different polymers that conduct electricity such as PPy, Polyaniline (PANI), Polyethylene (PTh). PPy has been the most studied of the polymers and has many favorable qualities such as biocompatibility, its stable, and high conductivity and its flexibility in other properties.² The second most studied conductive polymer is PANI. Compared to PPy, it has low flexibility, its non-biodegradable, and has been found to cause issues once it has been implanted.³

Technical Objectives

The main objective is to create a potentiotstat and test its performance. This device will then be used for electrochemistry (creating a galvanic cell) to facilitate the plating of polypyrrole (PPy) onto Hyaluronic Acid (HA)-fibers. The infused PPy will allow the HA-fibers to conduct electricity therefore allowing electrical stimulation of the neuronal cells through the scaffold.⁴

Technical Approach, Accomplishments and Results

The testing is ongoing, but the potentiotstat has been built. The code has been compiled and is subject to change depending on how much material needs to be deposited onto the scaffold. This deposition will be measured through how long the scaffold was in the solution (as more time passes the scaffold will continue to be coated).

Expected Results:

The expected results after the experiment has been completed will show that the less PPy that has been doped onto the scaffold the less growth will be seen. However, too much PPy may also have an adverse effect. The controllers will determine the duration of the experiment how the scaffold is made.

At the end of the month completed tasks will include:

• Completion of the Potentiostat (Testing)
• Creation of the (HA) Scaffold
• Coating the (HA) Scaffold
• Starting the testing of the scaffold

Next Steps for Development and Test

The next step will be testing the duration of the electrical stimulation. If this stimulation needs to be pulsed or continuous. This will have to address the pulses’ duration and length of the stimulation. Secondly, the type of scaffold will be tested – if the fibers of should be randomly aligned or aligned fibers.

Commercialization Plan & Partners

Atex technologies Inc. is a company that specializes in creating medical textiles that could help turn this idea into a commercial product. The main hurdles to be expected is that product must have to go through the FDA regulations (as currently, there are no conducting polymer tissue scaffolds that are FDA approved), the device must work in both in vivo and in vitro.° The scaffold must prove to be biocompatible, and biodegradable. Studies have shown that in vitro results are more favorable than in vivo. If there are other similar materials on the market, then this product would have to match or outperform its competitors.

References