Research Assessment #19

Date: February 22nd, 2021

Subject:Song, Shaochen, et al. “Additive Manufacturing of Nerve Guidance Conduits for Regeneration of Injured Peripheral Nerves.” Frontiers, Frontiers Media S.A., 25 Sept. 2020, www.frontiersin.org/article/10.3389/fbioe.2020.590596/full. Accessed 22 Feb. 2021.

Assessment:

In the past assessments, I have been able to gain an overview of nerve guide conduits and the different types of nerve conduit materials. Furthermore, my next priorities were to deduce the specific properties of a guide conduit that make it effective for nerve regeneration. Within the article “Additive Manufacturing of Nerve Guidance Conduits for Regeneration of Injured Peripheral Nerves.” I was able to find the gathered specific details about the vital mechanical properties of successful nerve guide conduits and also delve deeper into the methods used to create nerve guide conduits.

In general synthetic polymers tend to have superior mechanical properties since they are manufactured meticulously in a lab and can be adjusted accordingly to the nerve defect. However, natural biomaterials have rigid properties that are difficult to manipulate. Some of the important mechanical properties to consider are the diameter of the scaffolds, the diameter of the microchannels, the micropore size, the amount of surface roughness, and the hydrophilicity of the surfaces. To continue, the efficiency of the properties is rated depending on the length of axon regeneration and the number of neurite outgrowths (dendrite branches) they promote.

Besides axon regeneration and neurite growth, the amount of cell adhesion and absorption of proteins are also taken into account when deciding the success of the biomaterial. According to the articles, conduits with a microchannel diameter between 20-30μm, a micropore size between 10-40μm, a surface roughness between 85-200μm, and a larger amount of hydrophilic surfaces have displayed the best results for peripheral nerve repair. These parameters for peripheral nerve repair may be somewhat applicable to central nerve repair because the nerve structure is similar, however, the parameters may have to be more specific due to the bundled structure of neurons and nerves within the spinal cord. In my next mentor meeting, I will consult with Dr. Ecker to learn more about the limitations of nerves within the spinal cord and compare them to the nerves in the peripheral nervous system to get a better understanding of the necessary parameters for SCI.

In addition to mechanical properties, I was also introduced to an overview of the available conduit printing techniques. Moreover, I learned about 3 main types of printing techniques: microextrusion-based printing, stereolithography, and inkjet printing. Firstly, microextrusion printing uses a nozzle to distribute the biomaterial over layers until the desired shape is achieved. The disadvantage of this technique is the risk of blockage and lack of precision, which can be slightly avoided if a fusion deposition modeling technique is used. Secondly, stereolithography (SLA) printing uses laser light to cure the polymer conduit and can be separated into 2 subcategories: devices that use lasers to project the polymer image to increase layer printing and devices that use lasers to print the polymer by specific points. Although this technique has fewer disadvantages compared to extrusion-based printing, the type of materials that can be cured using this technique are limited. Lastly, inkjet printing is a recent advancement that prints polymers in through droplets along a 3D coordinate axis. There has not been much research into the efficiency of inkjet printing for nerve conduits but they do display a potential ability to successfully print composite conduits. Overall, inkjet printing seems to be one of the promising biomaterial dispensing techniques that can be used to precisely create nerve guide conduits.

In conclusion, through this article, I was able to gather the necessary details that provide efficient nerve guide conduits for peripheral nerve repair. Moving forward, some of my guiding questions that I hope to answer will be: How do central nerves regenerate when compared to peripheral nerves? How do mechanical property parameters of nerve guide conduits for peripheral nerves need to be adjusted for central nerve guide conduits?

Annotations for the article: https://kami.app/UVzfvggZ9LKb