Computational analysis of collagen delivery to the striatum

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Introduction

In recent years, cell therapy has emerged as a promising therapeutic strategy for Parkinson's disease. To increase cell viability, biomaterials are used to facilitate cell deposition, through injection, to the site of interest. However, the existing cell delivery approaches have shown limited success in clinical translation [1].This study aims to develop a device for the delivery of a cell-embedded *in situ* forming hydrogel. Here, computational approaches on the delivery of collagen to the striatum are presented, to gain insight into different parameters affecting the delivery.

Methods

The delivery of collagen to the striatum was modelled computationally in the two-dimensional space. The striatum was modelled as a circular space, with an area of 3.98 cm^2 corresponding to the mean volume of putamen in Parkinson's disease patients[2]. Within the finite volume method framework, the flow of collagen was considered incompressible, with non-Newtonian fluid behavior characterized experimentally, and constant inlet velocity corresponding to a maximum delivery volume.

Results

The effects of collagen injection on the velocity and pressure fields within the striatum were examined. Velocity streamlines and wall shear stress (WSS) values were also analysed near the edges of the needle, at the entrance of the collagen to the striatum. High WSS values may influence cell viability on the site of delivery.

Conclusion

Intrastriatal injection of a cell embedded hydrogel is a complex process which is not yet well characterized. Computational analysis of the delivery can assist to identify the obstacles facing clinical translation. Further analysis is required including 3D reconstruction from MRI images and computational modelling in the three-dimensional space.

References:

1. Amer, M. H., White, L. J. & Shakesheff, K. M. The effect of injection using narrow-bore needles on mammalian cells: Administration and formulation considerations for cell therapies. *J. Pharm. Pharmacol.* **67,** 640–650 (2015).
2. Yin, D. *et al.* Striatal volume differences between non-human and human primates. *J. Neurosci. Methods* **176,** 200–205 (2009).

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