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Flow simulation of a collagen solution in syringes with different geometries

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Introduction

In recent years, cell therapy has emerged as a promising therapeutic strategy for many diseases, including Parkinson's disease [1]. To increase cell viability, biomaterials are often used as scaffolds to facilitate cell deposition, through injection, to the site of interest. However, fluid forces acting on the cells during injection may lead to cell disruption or death [2]. This study aims to develop a novel device for the delivery of a cell-embedded collagen hydrogel, forming *in situ*. Here, we discuss computational results on constricted channels representing the connection between the syringe barrel and the needle to gain insight into the effect of syringe geometry.

Methods

Straight needles emanating co-axially from syringes of various geometries were modelled computationally in the two-dimensional space. A low dead space syringe design was modelled first (Geometry 1) and was compared with sudden and tapered contraction designs (Geometries 2 and 3). Within the finite volume method framework, the flow of a viscous collagen solution was considered almost incompressible, with non-Newtonian fluid constitutive behaviour, and constant inlet velocity that corresponds to a maximum delivery volume.

Results & Discussion

The effects of the syringe geometry on velocity and shear stress were examined at the syringe-needle connection. Simulation results demonstrated 10% lower velocity magnitude in Geometry 2 compared to Geometries 1 and 3. Wall shear stress calculations indicated a greater influence of Geometries 1 and 3 on the collagen solution; values at the entrance of the needle were found 40% higher in these two geometries than in Geometry 2.

Conclusion

This study highlights the importance of syringe geometry on the design of new cell delivery devices. As therapeutic cells pass from the syringe barrel to the needle, the pressure drop and the increased velocity could damage them. Further analysis is required including the simulation of cells during injection and understanding of their deformation.

References

1. Gunay MS., Ozer AY., Chalon S. *Curr Neuropharmacol.* 2016; 14(4): 376–391.
2. Aguado BA *et al. Tissue Eng. Part A* 2012; 18**:** 806–815.

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