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FLOW SIMULATION OF A NATURAL POLYMER IN A SYRINGE-NEEDLE DELIVERY DEVICE

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Recently, cell therapy has emerged as a promising therapeutic strategy for many diseases. Often, to increase cell viability, biomaterials are used as scaffolds. The cell embedded biomaterial can then be injected to the site of interest. However, when a material is incorporated in a delivery device several forces are applied. Additionally, fluid forces acting on cells may lead to cell disruption[1]. This study aims to develop a novel device for the delivery of a cell embedded *in situ* forming collagen hydrogel. A simulation study on constricted channels representing the syringe-needle connection was performed to gain insight into the effect of needle diameter. Utilising OpenFOAM, straight needles, emanating co-axially from a common syringe, were computationally modelled as 2D sudden contractions. The flow was considered incompressible, with non-Newtonian fluid constitutive behaviour, and constant inlet velocity corresponding to maximum delivery volume. The effects of needle diameter on velocity and shear stresses were examined. Simulation results demonstrated 48% higher fluid velocity in the 26-Gauge needle (Fig.1) compared to that of the 22-Gauge, and the accelerated fluid entered the needle from regions further away from the wall. Shear stresses indicated a greater influence of the higher-Gauge needle on collagen.

This study highlights the importance of needle diameter on the design of new cell delivery devices. As cells pass from the syringe barrel to the needle, the pressure drop and the increased velocity could damage them. This is more likely to occur using higher-Gauge needles. Further analysis is required including simulation of cells during injection and analysis of their deformation.

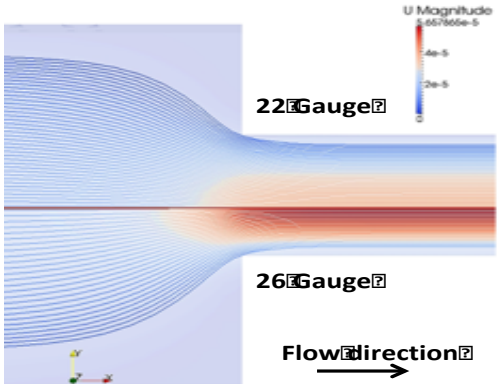

Fig.1: Velocity streamlines along simplified needles of 22-Gauge (top) and 26-Gauge (bottom) diameters.

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