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Quantification of Blood Flow in Chicken Embryos

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Extended Abstract

This extended abstract discusses a methodology and reasoning for an experiment that has not yet been performed, and as such, there are currently no results to present.

The goal of this study is to examine the rheological properties of human blood, a non-Newtonian fluid flow through microcirculation. We will attempt to quantify the blood's flow rate, viscosity and aggregation as it passes through the microcirculation. To do this, we are planning to examine the use of chicken embryos as a model for human blood flow. This will be done by removing the avian blood from an embryo that was incubated for approximately 50 hours, until it reaches stage 16HH (Hamburger and Hamilton, 1951). Once the embryo has been incubated, a window will be opened in the egg, the pericardium will be dissected open and the truncus arteriosus will be cut at the level of the ventricle, the avian blood will then be pushed out of the ventricle and removed. After all avian blood is removed; human blood will be injected through the opened truncus arteriosus of the developing heart and pumped through the embryonic blood vessels.

The embryo will be used at stage 16, because that is when the vitelline network, which is a flat network of blood vessels laying on the surface of the yolk sac, providing the embryo with nutrients, is well developed, but not too complex for the blood vessels to overlap (Kloosterman et al, 2014). Allowing the vessels to be more easily observed with a microscope that would examine the hemodynamic properties and topology of the network, and the changes brought upon these properties by blood aggregation modifiers such as dextran 70 which will be mixed in, at varying levels, with the blood.

There is a large amount of variation in the flow rate across different vessels of similar diameters, mainly due to the constriction of the smooth muscles around the vessel and at the entrance. So a relatively large area of vessels must be observed (Kloosterman et al, 2014), to examine what potential changes occur due to the modified blood aggregation.

The chicken embryo was chosen to be used because after windowing, it provides a very clear picture of the vitelline network. Also, due the fact that the avian blood is flushed out of the network and that the embryo can still get all of its nutrients through diffusion (Cruses, 2000), so there should be very little interference from the embryo's normal biological systems. It is also used because there are also many factors which a biological system has, that are very hard to mimic in a fabricated microfluidic system that would normally be used in such studies, such as vessel compliance and network complexity (Lee and Lee, 2010).

The intended endpoint of this experiment is to observe the changes that occur in blood flow due to modified blood aggregation in a biological system, and to test how well an embryonic chicken's vitelline network can be used as a model of a human vessel network.

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