New Flow-Stretch-Flexure Bioreactor for Mechanical Conditioning of Engineered Heart Valve Tissues

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Technology description

Background

Cardiovascular disease is a major cause of disability and death in the world. Examples include atherosclerosis, stroke, aneurysm, as well as congenital valve and septal defects. A number of other conditions, such as diabetes increase the risk of acquiring cardiovascular disease. In addition, the cost of related treatment and loss in work hours contributes significantly towards a national and global health care crisis and the economy at large. As an example, in the USA alone, over one-half million coronary heart bypasses are performed annually. In the last 15 years, rapid advances in the field of regenerative medicine could provide a long-term solution to several cardiovascular problems such as blood vessel and valvular disease. The reason for this lies primarily in the repair and/or replacement of the diseased tissue with biologically-derived materials/substitutes. Furthermore, patient-specific treatment strategies are possible, thereby ensuring minimal immune response from the host.
Cardiovascular tissues are subject to a diverse mechanical environment. It is now well-accepted that in order for tissue engineered cardiovascular tissues to be viable for implantation and remain functional long-term, they have to be suitably pre-conditioned in a dynamic mechanical environments. These environments can be created through the use of devices known as bioreactors.

Technology

A device mimicking the dynamics and the physiological scales of stresses, native to cardiovascular tissue was developed. This device is capable of producing physiologically relevant scales of fluid induced stresses, while at the same time allowing for flexural and/or tensile stresses to be applied to the developing tissue. This is all possible even with regular, relatively low-viscosity cell culture media, making it unneccesary to alter the media formulation. In addition, the nature of the flow can be easily adapted to either steady or pulsatile flow profiles. Higher shear stresses can be achieved with the current system with the use of a more viscous fluid. Current efforts are underway to utilize this system for mechanistic studies of heart valve tissue formation under physiological conditions to accelerate rates of cellular differentiation and tissue formation.

Application area

Mechanically pre-condition engineered cardiovascular tissues so that optimum properties are brought on prior to implantation

Advantages

1) capable of fluid-induced, flexural and tensile stresses and any combination
2) easily adaptable to pulsatile flow from steady flow 3) Flow is within physiologically relevant scales, possible even with regular, low-viscosity cell culture media

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