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Systems to Facilitate Adult Stem Cell Seeding and Conditioning of Aortic Heart Valve Scaffolds

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Depositing a confluent layer of cells on all surfaces. Providing conditions under which varying attachment Yost, Improving cell seeding efficiency and uniformity Sierad. A common treatment is replacement with either a mechanical or tissue-derived heart valve. Existing heart valve replacements provide major improvements in cardiac function and life expectancy, but have significant limitations and eventually require surgical replacement within 15-20 years.

In pediatric patients, mechanical implants are naturally outgrown and degradation and calcification of tissue-derived implants is accelerated. A device for uniform cell seeding will be required to facilitate the development of an autologous TEHV in the areas of:

- Depositing a confluent layer of cells on all surfaces.
- Improving cell seeding efficiency and uniformity over manual seeding regardless of user variations.
- Providing conditions under which varying attachment improvements can be evaluated and compared.

Existing heart valve replacements provide major improvements in cardiac function and life expectancy, but have significant limitations and eventually require surgical replacement within 15-20 years.

TEHV Generation, Seeding, & Testing

Porcine aortic heart valves were decellularized to remove the porcine-specific antigens, sterilized using peracetic acid, and stabilized with pentagalloyl glucose to control tissue degradation. Valve surfaces were incubated in 50% serum in cell culture medium overnight to neutralize any remaining pentagalloyl glucose molecules then coated with Fibronectin or Pronectin to improve cell attachment.

Valves were mounted in individual seeding chambers, seeded with 15 to 24 million porcine aortic endothelial cells (pAECs) or human adipose-derived stem cells (hASCs), and rotated according to multiple regimens. Cell seeded valves were placed in a dynamic heart valve bioreactor under pulmonary or aortic pressures. Valves were evaluated for initial attachment, retention after bioreactor testing, and viability throughout.

Cardiovascular disease causes 750,000 deaths annually in the US. Valvular heart disease is characterized by abnormal tissue stiffness and calcification, stenosis, or thromboembolism of valve leaflets, which can limit the functionality of aortic valves.

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Conclusions

- The treated surface was compatible with both cell types.
- Device design and protocol enabled a reproducible & semi-automated seeding process.
- Made progress toward achieving a confluent valvular endothelium layer.
- Cells were retained on the scaffold surface under pulmonary pressure conditioning in the bioreactor.
- Surface seeding has been successful with two cell types and is quickly progressing toward a translational regenerative TEHV fully seeded with the patient’s own cells.

Acknowledgements

- St. Jude Medical, Inc. 2005

References

2. Sierad, Cardiovascular Engineering and Technology (2010)