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EDITORS' CHOICE | TISSUE ENGINEERING

50 shades of red

Christopher M. Jewell

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Abstract

Synthetic heart valves designed from slowly degrading polymer enable gradual replacement by new host tissue during a 12-month study in sheep.

No matter what shade of red your Valentine's Day was last month—sultry or sullen, sad or sweet—your heart beat more than 100,000 times, pumping 7500 liters of blood. Designing a device to achieve such precision and maintain it over a lifetime (about 70 years) requires integration of biology and engineering at a staggering level. Understandably then, despite great progress, design of adaptable, living heart valves has not been achieved. Prosthetic valves, for example, are nonliving structures that lack the functionality to respond to dynamic blood flow across days and years or the ability to grow with younger patients. Bouten and colleagues tackled this challenge with a fully synthetic heart valve designed from slowly degrading polymer that utilizes structural features to promote colonization by host cells,

allowing the synthetic valve to be slowly replaced by functional tissue.



In this approach, valves were formed by electrospinning biodegradable polymer fibers onto a polymer support. This strategy allowed design of topography and pore sizes known to encourage host cell infiltration, extracellular matrix production, and tissue remodeling. During a 1-year study in sheep, the valves maintained good cardiac function, and, importantly, became increasingly tissue-like when implanted as replacement pulmonary valves. At 2, 6, and 12 months, valves exhibited increasing infiltration of host cells, endothelialization, and ultimately generated new tissue, including elastin. As these processes occurred, the composition of biological components in and on the valves—for example, elastin and collagen—began to resemble native tissue. During these same intervals, the polymer fibers comprising the valve degraded, and the mechanical properties of the initial synthetic valve evolved to a more tissue-like elastic profile.

Existing synthetic heart valves are hindered by static dimensions and the need for material properties that closely match the profiles of natural valves. Likewise, tissue-engineered heart valves have required cells seeded in valve constructs prior to implantation, tissues or matrices from human donors, or scaffolds created by decellularizing tissue. Thus, this new report is distinct in that the entirely synthetic valves do not require cells or biological matrices but lead to the formation of adaptable, living tissue as the polymer degrades. Effectively translating this idea to the clinic might just keep your heart from skipping a beat.

Highlighted Article

J. Kluin, H. Talacua, A. I. P. M. Smits, M. Y. Emmert, M. C. P. Brugmans, E. S. Fioretta, P. E. Dijkman, S. H. M. Söntjens, R. Duijvelshoff, S. Dekker, M. W. J. T. Janssen-van den Broek, V. Lintas, A. Vink, S. P. Hoerstrup, H. M. Janssen, P. Y. W. Dankers, F. P. T. Baaijens, C. V. C. Bouten, In situ heart valve tissue engineering using a bioresorbable elastomeric implant – From material design to 12 months follow-up in sheep. *Biomaterials* **125**, 101–117 (2017). [Google Scholar](#)

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