Medical Xpress

# Computer-designed heart valves implanted into sheep for the first time

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Credit: AI-generated image

According to the European Society of Cardiology, cardiovascular diseases are the leading cause of death in Europe. Each year, 3.9 million people die here from heart disease, which is responsible for 45 % of all deaths on the continent.

Heart valve replacement surgery remains the most common treatment for damage or defects in one of the four heart valves. But around a third of patients face problems within 10 years of receiving the implant and often require further, potentially life-threatening corrective surgery.

In 2009, an international consortium of scientists embarked on a partly EU-funded project called LIFEVALVE to develop a more efficient strategy for treating patients with heart valve disease. Now, following years of research, they have made significant progress towards the use of regenerative heart valves to treat heart disease patients in the future. Using computer simulations, they have designed and successfully implanted regenerative heart valves into sheep for the first time. Their results are presented in a paper published in the journal *Science Translational Medicine*.

## Computer design of heart valves

The heart valves the team designed and implanted were cultured from human cells. Using computer simulations, the researchers predicted how the prostheses would grow, regenerate and function in the animal. "Thanks to the simulations, we can optimise the design and composition of the regenerative heart valves and develop customised implants for use in therapy," explained project coordinator Prof. Simon Hoerstrup of the University of Zurich in a news release published on the University's website.

Regenerative medicine is a branch of research that uses tissue engineering and molecular biology to generate living tissue or organs from human cells. The tissue and organs are used to repair or replace defective human cells, tissues or organs. This is done to restore or establish normal function.

Such bioengineered replacements overcome a number of drawbacks that current artificial implants have. For example, mechanical heart valves may last indefinitely, but patients are required to take anticoagulants throughout their lives to prevent blood clots. Furthermore, while patients with animal tissue (or biological) prostheses may not need to take anticoagulants, such valves wear out in time. They're also prone to abnormal thickening and calcium build-up, as well as immune system complications. Lack of regeneration is also a severe problem in current artificial prostheses, and especially for children with congenital heart defects. Since these prostheses can't grow and regenerate, such children face multiple operations in their lifetime to have valves replaced as their bodies grow. Since the team's tissue-engineered prostheses don't cause immune reactions and are able to grow and regenerate themselves, they stand to offer significant improvements in the quality of life of both young and adult patients.

Certain obstacles still need to be overcome before the technology can be used in routine clinical practice. "One of the biggest challenges for complex implants such as heart valves is that each patient's potential for regeneration is different. There is, therefore, no one-size-fits-all solution," Hoerstrup stated.

LIFEVALVE (Living autologous heart valves for minimally invasive implantable procedures) research is being continued with the aim of bringing the first tissue-engineered heart valve on the global market.

**More information:** Project web page: cordis.europa.eu/project/rcn/92537_en.html

Maximilian Y. Emmert et al. Computational modeling guides tissue-engineered heart valve design for long-term in vivo performance in a translational sheep model, *Science Translational Medicine* (2018). DOI: 10.1126/scitranslmed.aan4587

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