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News

STS Press Release
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3D Printed Tissue Offers Viable Option for Tracheal Reconstruction

Printed material can be combined with patient's own cells for customized tissue segments

San Diego – Three-dimensional (3D) printing can effectively create a biodegradable tracheal segment containing a patient's own cells for use in complex tracheal reconstruction, according to a proof of concept study abstract released today at the 51st Annual Meeting of The Society of Thoracic Surgeons.

The trachea, sometimes referred to as the "windpipe," is a tube that connects the upper respiratory tract to the lungs and helps carry air to the lungs. Traditional treatments for tracheal diseases such as stenosis (narrowing) or malacia (abnormal softening of the tissue) usually involve removal of the affected tracheal segment.

"Three-dimensional printing and tissue engineering has the potential for creation of a custom-designed tracheal replacement prosthesis in the lab so that the affected tracheal segment can be 'swapped out' instead of removed," said lead author Todd Goldstein, PhD, of the Feinstein Institute for Medical Research, part of the North Shore-LIJ Health System in New York.

Key Points

- 3D printing can create a tissue-engineered biodegradable tracheal segment with a patient's own cells that can be used in complex tracheal reconstruction procedures.
- These results show that 3D printing technology is a feasible alternative to traditional treatments.
- The authors said that 3D printing has the potential to revolutionize medicine; patients are already seeing benefits from the technology in the area of customized prosthetics for limb replacement.

Dr. Goldstein and colleagues used a custom-designed 3D printer that had been modified by engineers to enable printing of living cells. The printer produces a biodegradable structure (scaffold) that can be combined with living cells to create a tracheal segment. The size and shape of the scaffold can be customized for each patient.

For their study, the researchers made three types of printed segments: empty segments, segments without cells (controls), and segments that had been combined with living cells. The bio-printed cells were tested for viability, proliferation (cell growth and division), and gene expression. The researchers found that the cells survived the printing process, were able to continue dividing, and produced the cellular properties expected in healthy tracheal cartilage.

"Our results show that three-dimensional printing can be combined with tissue engineering to effectively produce a partial tracheal replacement graft in vitro," said Dr. Goldstein. "Our data demonstrate that the cartilage cells seeded on the graft retain their biological capability and were able to proliferate at the same rate as native cells."

The authors said that 3D printing has the potential to revolutionize medicine; patients are already seeing benefits from the technology in the area of customized prosthetics for limb replacement. Reconstructive craniofacial and cardiothoracic surgeons also have been using 3D printers to build models for more precise surgical planning.

"Tissue engineering has seen remarkable advances in recent years, and Goldstein and colleagues demonstrate here that 3D printing of biodegradable airway scaffolds is feasible and that such scaffolds can be populated using patient self-derived cells," said Andrew C. Chang, MD, from the University of Michigan Health System in Ann Arbor, who was not involved in the study. "While their work could have considerable and obvious impact in advancing surgical therapy for patients with tracheal disease, it remains to be demonstrated whether this in vitro accomplishment can make the leap to clinical application as a vascularized and durable airway substitute."

"We think the next phase will be integrating three-dimensional printing and tissue engineering to produce customized biological replacement parts," said Dr. Goldstein. "While further development is necessary before a clinical trial would be viable, our results show that 3D printing technology is a feasible alternative to traditional treatments."

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Note: 3D printed tissue is not approved by the US Food and Drug Administration.

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