Researchers sound out scaffolds for eardrum replacement

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An international team of researchers has created tiny, complex scaffolds that mimic the intricate network of collagen fibres that form the human eardrum.

It is hoped the scaffolds can be used to replace eardrums when they become severely damaged, reducing the need for patients to have their own tissue used in reconstruction surgery.

The scaffolds have been presented today, 7 May, in IOP Publishing's journal *Biofabrication*.

The eardrum, otherwise known as the tympanic membrane (TM), is a

thin, flexible and tough membrane that separates the external ear from the middle ear.

The eardrum is composed of collagen fibres that are precisely aligned in a complex network to enable sound waves to be transmitted to the ear ossicles— three tiny bones in the ear.

It is quite common for the eardrum to become perforated, especially in children, through infection or physical damage, which can often lead to temporary hearing loss. Most minor damage to the eardrum can heal on its own; however, more severe damage can require a type of surgery known as myringoplasty.

One of the first recorded attempts at repairing the eardrum was made in the 17th century using an ivory tube covered by pig's bladder.

Since then, researchers have investigated several different techniques to repair or replace the eardrum, using a patient's own tissue (an autograft) or tissue taken from a donor (a homograft), but the optimal replacement has yet to be found.

In this study, the researchers explored a tissue engineering approach by creating polymer scaffolds onto which cells could be grown on. The scaffolds were composed of two FDA-approved copolymers of wide biomedical use and were built using two different approaches.

In the first approach, the scaffolds were created by electrospinning (ES) in which fine fibres of poly(lactic-co-glycolic acid) (PLGA) were drawn out from a liquid using an electrical charge to create a one dimensional structure.

In the second approach, ES was combined with 3D printing to manufacture two dimensional and three dimensional structures from

poly(ethylene oxide terephthalate)/poly(butylene terephthalate) (PEOT/PBT) with radial and circular patterns.

The sizes of the scaffolds were comparable to that of a human eardrum, with a diameter of 15 mm and a thickness of around 100 μm.

Once created, a preliminary biological study was conducted by culturing human mesenchymal stromal cells (MSCs) onto the scaffolds to test how cells could grow and then survive on the structures.

The cells were viable when grown on all of the scaffolds, with particularly good results seen on the three dimensional scaffold.

Co-author of the study Dr Serena Danti, from the University of Pisa, said: 'Since the eardrum is a unique tissue in the human body, traditional replacements are usually autografts that have come from other tissues which do not have specific structural similarity with the eardrum. Consequently, their acoustic performances are not optimal.

'The eardrum has a complex structure with collagen fibres arranged precisely to interact with sound waves. We have replicated this structure in our scaffolds by combining electrospinning with 3D fibre deposition, and we believe this will eventually allow for replacements that are anatomically and acoustically similar to the eardrum.'

More information: "Multiscale fabrication of biomimetic scaffolds for tympanic membrane tissue engineering." 2015 *Biofabrication* 7 025005 DOI: 10.1088/1758-5090/7/2/025005

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