Ear to the future: Donated cells transform from lab to mouse

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Within a Northeast Ohio lab, a hairless mouse is growing an ear from the cells of a Wadsworth, Ohio, preschooler.

Dr. William Landis, the G. Stafford Whitby Chair of Polymer Science at the University of Akron, is leading groundbreaking, tissue-engineering research to grow human cartilage - first in the lab, now in animals and, eventually, in patients.

His work is part of a fast-developing field that could help millions of patients repair injuries, replace worn body parts or fix birth defects with tissue grown from their own cells in the not-so-distant future.

"I think that in the future, we will all grow our own replacement tissue," Landis said.

Through a new partnership with Dr. Ananth Murthy, clinical director for plastic surgery at Akron Children's Hospital, Landis and his team are obtaining ear cartilage for research from patients whose families consent.

Kyle Figuray's parents agreed to be the first area participants and donors of his otherwise useless cartilage.

The healthy, friendly 5-year-old was born with a congenital defect that caused the exterior ear and ear canal on his right side to develop improperly.

Typically, the malformed ear cartilage is discarded as medical waste after it's removed during the first of three procedures to craft a new ear out of rib.

Instead, the tissue removed by Murthy during Kyle's surgery last month was placed inside a vial and shared with Landis' research team, who carefully cleansed the cells and fed them special nutrients to coax them to proliferate in the lab.

A few weeks later, enough cells were available for researchers to "seed" them onto a biodegradable, biocompatible polymer scaffold.

The scaffold provides the framework for the cells to grow and take shape. The cells "will reside on the polymer," Landis said. "If they like it, they will actually develop finger-like projections that allow them to grab hold of the polymer and then begin to multiply and grow."

A few days later, the seeded ear scaffold was implanted under the skin of a hairless mouse at the Northeastern Ohio Universities Colleges of Medicine and Pharmacy in Rootstown Township. The research animal was specially bred without an immune system so it won't reject foreign tissue such as that from Kyle.

The mouse will be studied over the next year to determine how the cells are behaving and progressing toward normal cartilage. If all goes well, the biodegradable polymer scaffold should disappear, leaving behind only Kyle's cartilage cells in the shape of an ear.

The hope is that an affected person's cells someday can be harvested, seeded onto similar polymer scaffolds and implanted under the patient's own skin in the abdomen or back until they grow into replacement tissue. At that point, the new tissue could be removed and used to replace the patient's injured or defective tissue.

Because the ear cartilage would be grown from a person's own cells, the risk of rejection should be eliminated. The same concept could apply to cartilage for digits, joints and other tissues.

Landis' research differs from tissue-engineering work being done at other laboratories worldwide because it uses ear cartilage from children with a birth defect that causes the outer ear to develop improperly - a condition known as microtia.

It's not understood whether this microtia cartilage is identical to normal cartilage, Landis said.

"Normal cartilage has been tissue-engineered in many instances by many different laboratories across the world," Landis said. "Microtia cartilage has not. We may be the first laboratory attempting to grow and analyze microtia cells for possible tissue-engineering purposes."

The research uses an ear-shaped polymer scaffold developed by a Japanese company and colleagues there who have been collaborating with Landis for several years.

But his group is also collaborating with a number of other researchers at the University of Akron to use the school's biomaterials expertise to develop polymers for the same application, Landis said.

The current procedure to carve a new ear from a patient's rib cartilage, while effective, could be greatly improved with tissue engineering, Murthy said.

"The pipe dream is: What if you could grow cartilage in the lab that is from the patient?" he said. "That way, you don't have to take the cartilage out of the ribs.... It would be a quantum leap in the way we treat these sorts of defects. Hopefully, in less than 10 years, that will be a reality for us."

In Kyle's case, the surgery to sculpt a new ear using the current method worked well.

The preschooler bounced back to his normal, active self quickly and didn't complain much about pain, even from the incision in his chest, his parents said.

About a week after the procedure, his parents got to see their son's new ear for the first time when Murthy unwrapped the protective gauze to inspect his work.

"Are you ready to get this thing off?" Murthy asked Kyle, who sat stoically on the examining table.

Although swollen and slightly red, Kyle's right ear was the same shape and size as his left ear for the first time in his young life. His mother snapped a few pictures for the scrapbook.

"It looks like an ear," Murthy said, smiling with satisfaction.

"I think that really looks very, very good," Kyle's father agreed.

At first, Kyle was protective of his new ear and reluctant to let his parents wash it or put water on it. Kyle's getting used to it now, though he occasionally stops to inspect the ear in the mirror or run his fingers over it.

He still wears a plastic protector over the ear at night and when he plays with other children.

He'll undergo another procedure in about five months to separate his ear from his head and create the typical groove between the ear and the head. Without the separation, it would be difficult, for instance, to wear glasses or sunglasses.

During that time, his parents also have the option of attempting to provide Kyle with hearing on his right side through a bone-anchored hearing aid that would transmit sound waves from his skull to his cochlea.

Roughly six months later, Murphy will perform a third operation to make final adjustments to Kyle's new ear.

The tissue-engineering concepts being explored by Landis and his research team have wide-reaching implications for a variety of health concerns.

At research labs throughout the world, scientists are investigating ways to nourish human cells and coax them into the proper shape and function of not only cartilage, but also bones, heart valves, pancreases and numerous other tissues and organs.

Tissue-engineering inventions involving skin tissue replacement for ulcerations and a scaffold that slowly releases an anti-cancer agent to treat a form of brain cancer already are in use, according to the National Science Foundation.

"This is a very new paradigm for medicine," Landis said.

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