Lab-grown blood vessels could be big medical advance

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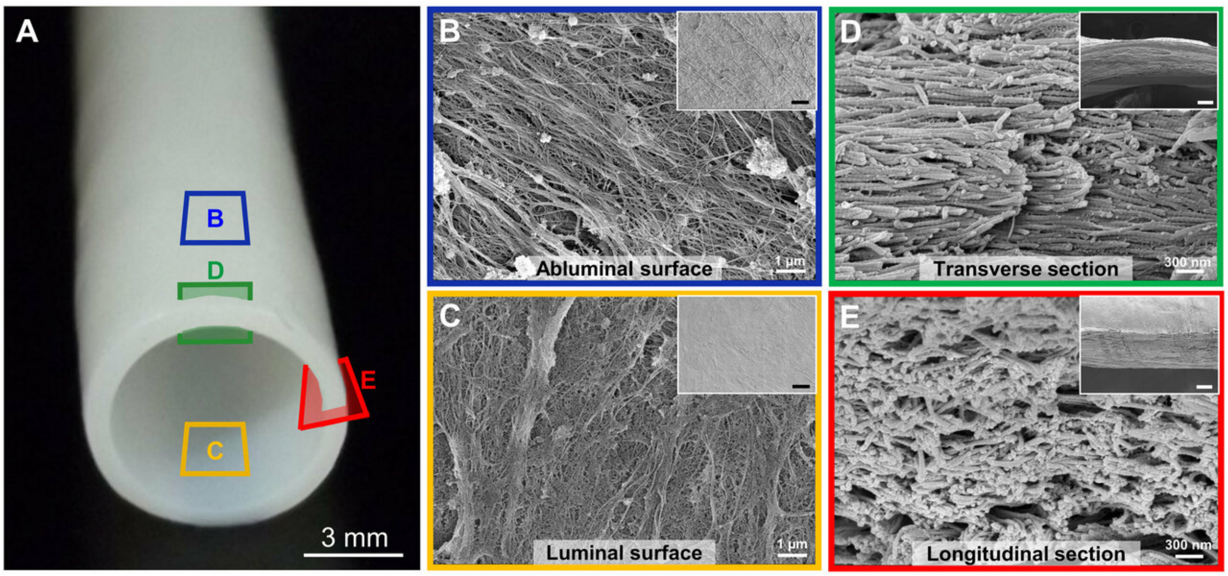


An example of the bioengineered human acellular vessel. Images depict the microscopic architecture of each section (B-E). Credit: R.D. Kirkton et al., Science Translational Medicine (2019)

Blood vessels created in the lab can successfully turn into "living tissue" in patients on dialysis for advanced kidney disease, a new study suggests.

The results come from just 13 patients in an early-phase trial. But researchers said they are a sign that the engineered tissue might eventually offer new treatment options for patients with damaged blood vessels—due to conditions ranging from heart disease to traumatic injuries.

The study, published March 27 in *Science Translational Medicine*, involved kidney disease patients who were implanted with the lab-created blood vessels so they could receive dialysis.

Right now, the "gold standard" way to give patients dialysis is by creating a fistula, a kind of surgically-made passage, said Heather Prichard, senior researcher on the study.

To do that, a surgeon joins a vein and artery in the patient's arm or leg, which allows blood to travel through tubes into the dialysis machine, where toxins are removed.

But, Prichard said, some patients' veins are not strong enough.

In those cases, a synthetic implant may be used to join a vein and artery. But the implants can't mimic real vessels, and they carry a greater risk of blood clots and infections.

So Prichard and her colleagues at Humacyte, Inc.—a Durham, N.C.-based biotech company—took a different approach. They created blood vessels in the lab.

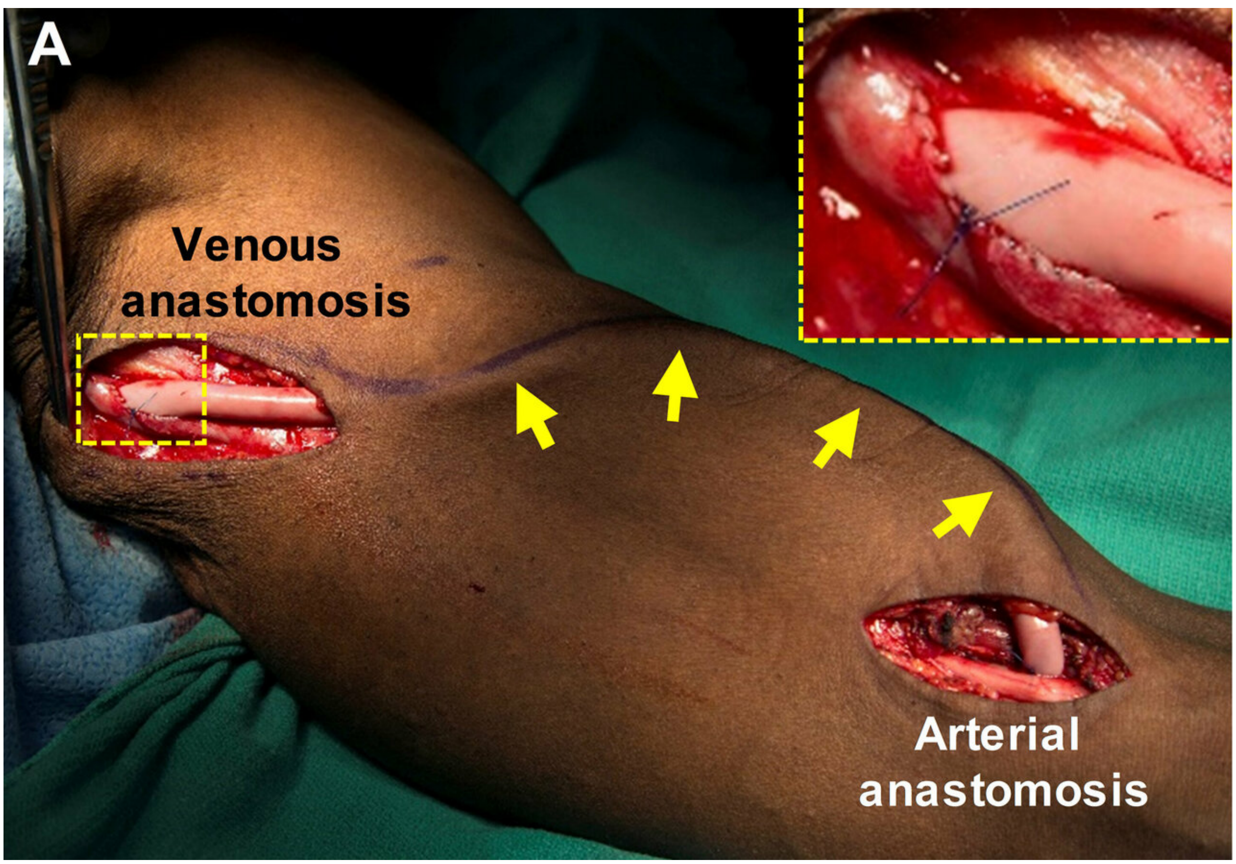
The researchers started with biodegradable, tube-like scaffolds, which they seeded with smooth muscle cells from deceased human donors. The scaffolds were then housed in a bioreactor system to develop for eight weeks. After that, researchers removed all cells from each structure, leaving behind a matrix that essentially provided the outer shell of a blood vessel.

The idea, Prichard explained, is that once the vessel is implanted, the patient's own cells will gradually populate it, making it similar to the body's native blood vessels.

Based on the new findings, the concept may work.

Researchers have been able to analyze tissue from the 13 patients who took part in the early study of the implants. They found that the patients' own cells and tiny blood vessels had migrated to the engineered vessels.

"The patient's cells can repopulate it and make it living tissue," Prichard said.



The researchers implanted the human acellular vessel (yellow arrows) into the forearm of a patient with end-stage renal failure. Credit: R.D. Kirkton et al., Because the vessels do not contain foreign cells, she said, a patient's immune system shouldn't reject them. There were no signs of an immune response in the tissue from the 13 patients.

But much more research remains: The company is now running two later-stage trials, comparing the engineered vessels with standard approaches in kidney dialysis patients.

As it stands, there is no evidence the vessels work any better than the "well-established materials in clinical use," said Dr. Frank LoGerfo, a professor of surgery at Harvard Medical School in Boston. He was not involved in the study.

It's also unclear whether the structures can form an "endothelialized" lining that helps them fully function like blood vessels, LoGerfo said. Nor is it clear how durable they will be under "full arterial pressure" from blood flow, he added.

The ultimate hope, according to Prichard, is to be able to create large numbers of engineered blood vessels that doctors can essentially obtain "off-the-shelf" for use in patients with various vascular illnesses, including heart disease.

That's different from the labor-intensive process of custom-engineering a blood vessel from a patient's own stem cells.

Another vascular surgeon who was not involved in the study called the progress being made toward bioengineered vessels "exciting."

"Having a vessel that handles and acts like real tissue is the 'holy grail,'" said Dr. Stephen Hohmann, of Baylor Scott & White Heart and Vascular Hospital in Dallas.

"If you could have a tube, of any size, that acts like a blood vessel—and have it available off-the-shelf—that would open up a whole world," Hohmann said.

He stressed, though, that "there is still a way to go before that happens."

The more immediate question, Hohmann said, is whether these engineered vessels can perform any better than existing approaches for dialysis patients.

In addition to the dialysis trials, Prichard said her company has begun two other studies.

One is focusing on patients with peripheral artery disease, a condition in which narrowed arteries reduce blood flow to the limbs. The other is on patients with traumatic blood vessel injuries that require surgery.

More information: Robert D. Kirkton et al. Bioengineered human acellular vessels recellularize and evolve into living blood vessels after human implantation, *Science Translational Medicine* (2019). DOI: 10.1126/scitranslmed.aau6934