Engineering transplantable vascular tissue with sound

Byungjun Kang
Jisoo Shin
Hyun-Ji Park
Chanryeol Rhyou
Donyoung Kang
Shin-Jeong Lee
Young-sup Yoon
Seung-Woo Cho
Hyungsuk Lee

Video Abstract

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Abstract

Sound waves. They bring music to our ears, help doctors peer inside our bodies, and even allow us to “see” underwater. Now, scientists are using these versatile packets of vibrating energy for a new application: growing functional, transplantable blood vessels right on the benchtop. These engineered tissues can be used to repair injuries caused by diminished blood flow from blood clots or other blockages. But there’s a lot to consider when fabricating therapeutic blood vessels. There are biological and mechanical attributes that are tricky to get right. The body’s vasculature is complex and multiscale, and a precise geometric arrangement is needed for efficient perfusion. Vessels are also composed of multiple cell types, which need to be well integrated to function. To engineer tissues that meet these requirements, scientists developed a new acoustophoretic cell patterning technique. The method uses sound waves to precisely align cells into user-defined patterns. In a new report in *Nature Communications*, researchers used the technique to replicate the microvessel structure found in skeletal muscle. To accomplish this, they combined human adipose-derived stem cells and endothelial cells with a biocompatible hydrogel. Before the gel solidified, the mixture was exposed to standing surface acoustic waves. These tunable sound waves directed the cells into uniform rows mimicking microvessels. As the hydrogel solidified, it held the cells in place, and they grew and matured in their new orientation. That orientation was far more anatomical than that produced by cells not exposed to the sound waves. It also enhanced microvessel-like gene expression. But the team still needed to show the artificial vasculature could help repair damage. For that, they transplanted the acoustophoretically patterned tissue into sites of ischemic injury in mice. The results were quite promising. The animals’ native blood vessels actively integrated with the transplants, which provided the blood supply needed to prevent tissue loss. More work is still needed before the technique is ready for use in humans, but the study offers an important advance to the field of regenerative medicine. Using different conditions with the acoustophoretic device may also reveal ways to engineer tissues compatible with other organ systems.