Fastinform

Breakthrough tissue-engineering method could regrow muscles with tissue alone

By Howard Hardee
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Scientists at Rice University have developed a new way of making scaffolds from electrospun skeletal muscle that, unlike previous approaches, can be executed with skeletal muscle tissue alone, providing an approach that may someday help people regrow muscle tissue after injuries.

As described in a study published Friday in *Science Advances*, the researchers used existing technology in a new way through the application of electrospinning, or generating extremely small fibers via electrical forces. They electrospun microscale threads derived entirely from muscle tissue that had been decellularized, or extracted from living cells in such a way that it retained its structural characteristics, ultimately yielding scaffolding designed to promote the regeneration of surrounding muscle.

While other laboratories have electrospun skeletal muscle tissue to create similar scaffolds, they have done so while blending the tissue with a synthetic polymer. To the knowledge of the paper's lead author, Rice bioengineer Mollie Smoak, this study marks the first time skeletal muscle tissue has been electrospun by itself. "We're really excited about this new avenue not only for skeletal muscle, but [that it] could also be applied to a number of different tissues," she told *Fastinform*. "We're excited about this new process."

Tissue engineering has progressed rapidly in recent years and months. Researchers at the Georgia Institute of Technology recently designed a sandwich-like scaffold for growing human tissues and organs. And other published studies have looked at decellularizing skeletal muscle. Decellularization has gained popularity over the past decade as a method of tissue engineering because the materials are robust in both nutrients and biochemical cues, Smoak said.

Electrospinning has also been used for decades to make micro- and nanoscale fibers. In the new work from Smoak and her colleagues, extremely fine threads of decellularized muscle tissue make up a scaffold designed to degrade as it is replaced by new tissue growth. Biochemical cues are present on the surface of the scaffold and also released as products of degradation, directing myotubes — the smallest building block of skeletal muscle — to mimic surrounding muscle fibers.

"Ideally, for tissue engineering, you want to promote the in-growth and differentiation of new tissue as your material degrades, so it's essentially replaced with new tissue," Smoak said. "We're able to provide these tunable material properties, but also with something that is going to degrade and release biochemical cues, versus something synthetic that, as it degrades, isn't going to release anything that is going to be advantageous for the cells. It may be bioinert, and that's fine, but it's not going to be advantageous like the degradation of our material will be."

The material's tunability means that it can be adjusted to meet the needs of the nearby muscle cells. "If you picture your own muscles, they're very highly aligned and parallel, so they can perform a contraction in synchrony," she explained. "For this particular application, we wanted something with mechanical properties similar to muscle, which we were able to achieve, and also an architecture that mimics skeletal muscle. So these fibers are highly aligned and parallel as well."

The study's authors envision that the new method of muscle regeneration could potentially help patients who've lost a significant volume of muscle mass and require reconstructive surgery as a result of battlefield injuries, surgical operations or severe automobile accidents.

"Muscle does have a really high capacity for self-repair, but when you remove more than 20%, it can no longer heal itself," said Smoak. "You have these physical deficits that are cosmetic but really impact people's sense of self. But it's also functional and impacts the surrounding tissues, muscles and skeletal system."

"The idea would be to hopefully promote new growth in the defect site where this muscle is lost, and help the existing muscle grow back," she added.

At this point, it's still just an idea that has been demonstrated in a lab but not in experiments with humans, Smoak said. Although she and her colleagues recently tested the technology in a rat model — the focus of a forthcoming paper — the concept is a long way from being applied in clinical settings. But in her view, the research project represents a promising step toward understanding how to fully and functionally restore skeletal muscle in people who have been badly injured.

"Part of the problem is that, even if you can get it to grow back and look like skeletal muscle, it's not functioning the same as before it was lost," she said. "There are definitely still a lot of limitations not only for this technology but also for the field and figuring out that missing piece of why we can't get function to be restored yet."

The study, "Bioinspired electrospun dECM scaffolds guide cell growth and control the formation of myotubes," published May 14 in Science Advances, was authored by Mollie M. Smoak, Katie J. Hogan, K. Jane Grande-Allen and Antonios G. Mikos, Rice University.