



Repairing Torn Ligaments

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Many sports-related injuries involve soft tissues such as ligaments, which connect bone with bone, and tendons, which join muscle to bone. Each year, more than 200,000 people suffer damage to their anterior cruciate ligament (ACL), the primary ligament that stabilizes the knee joint. With the rate of ACL tears and other soft tissue injuries increasing in all segments of the population, it is a hopeful sign that Helen H. Lu has developed a new approach to help the body heal after these debilitating soft tissue injuries.

One of the major hurdles preventing healing lies in integrating soft tissue grafts with the body, and Lu's group has focused on engineering the interface that connects soft tissue to bone. While tissue engineering has traditionally involved a single-tissue approach, Lu is growing multiple tissues to build functional organ systems that will integrate with the body.

"With the ACL-bone interface, we see three distinct yet continuous tissue regions—ligament, fibrocartilage, and bone," said Lu. "As we understand how the biological interfaces between these different types of tissues are formed and how to reestablish these distinct tissue-to-tissue boundaries post-injury, we can regenerate the native soft tissue-to-bone interface and promote integration."

Lu has developed a novel "scaffolding" to grow these three different tissue types within one functional system. This interface scaffold is stratified, with each layer differing in architecture, porosity, and composition to best nurture each particular cell type, while integrating seamlessly with the adjacent tissue. Each portion of the scaffold is biocompatible and biodegradable, and will ultimately be replaced by living tissue, thus becoming part of the body.

Lu and her research group are working on the design of an integrative interference screw. The interference screw, used to fix an ACL graft in place, is usually made of titanium alloys, but a tissue-engineered screw has none of the drawbacks of a permanent metallic implant and promotes integrative repair. This new method will move ACL repair from traditional mechanical fixation to biological fixation, resulting in longer-lasting and stronger repair.

Lu's group is extending the interface tissue engineering approach to the repair of another critical soft tissue-to-bone transition area, the rotator cuff. Tears in the rotator cuff are one of the most debilitating and common injuries of the shoulder. In collaboration with Dr. William Levine, a shoulder surgeon at Columbia, Lu is developing special nanofiber-based scaffolds that mimic the native tissue in organization as well as functionality for integrative rotator cuff repair.

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