How did your shoulder form?

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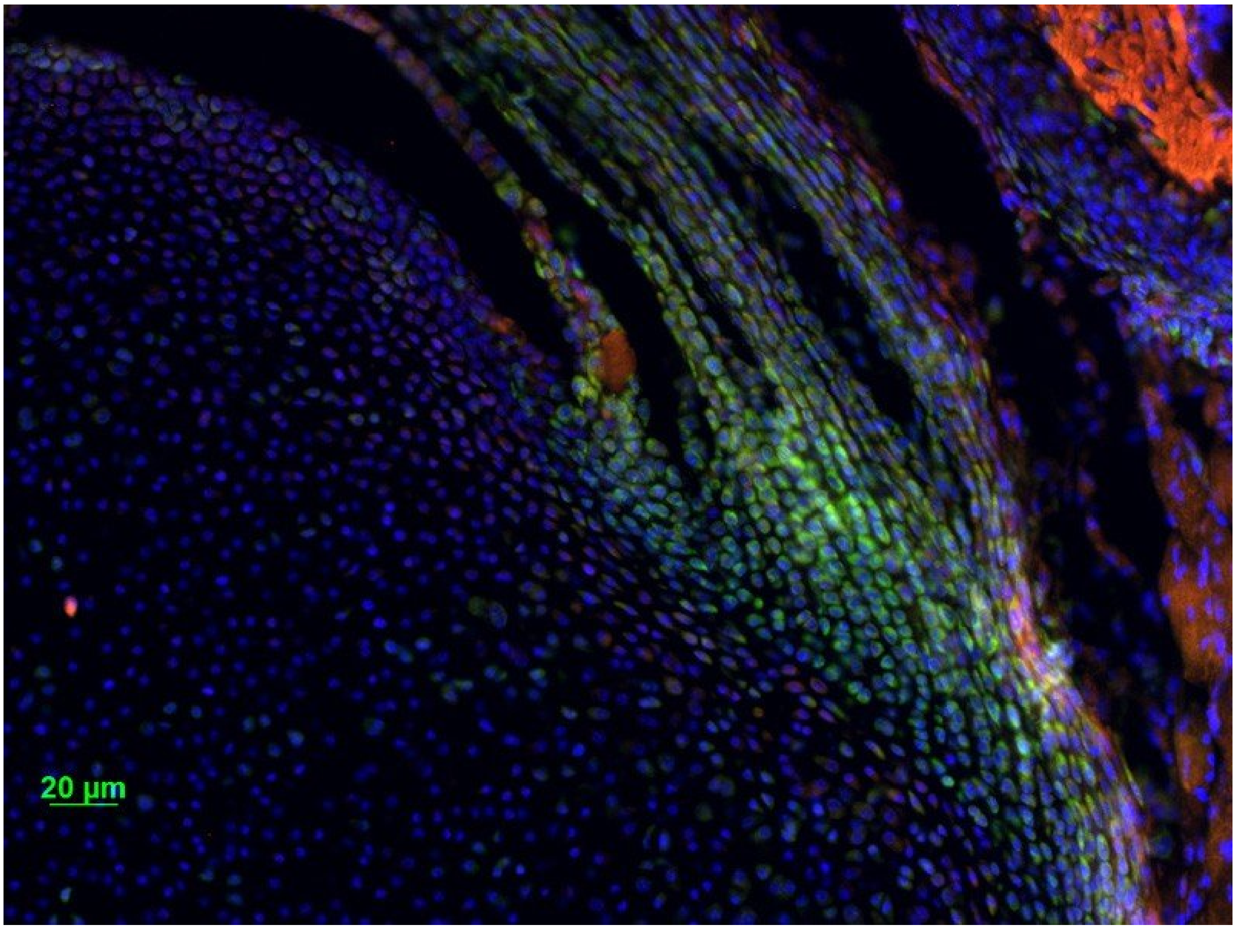

Microscopic view of shoulder tissue. Credit: Megan Killian

Whether you're pitching a baseball, playing a violin, or typing at your desk, your shoulder helps you get the job done. This joint is a complex machine, and in order to protect shoulders from injury, scientists want to develop a better understanding of how the most delicate parts of these joints work.

At the University of Delaware, assistant professor of biomedical engineering Megan Killian is using novel methods to study muscle activity during the maturation and healing of the rotator cuff, the group of muscles and tissues that helps to keep the shoulder joint in place. Killian recently received a grant from the National Institutes of Health for this work.

"The main thrust of this research is focused on how tendons and their attachments to bone are formed and remodeled with loading from active muscle contractions," said Killian. She is addressing problems with how the enthesis, the graded attachment site between the tendon and bone, forms in response to muscle loading, a critical factor in its development.

"Clinically, loading of the rotator cuff is an issue, especially in the case of disorders such as obstetric brachial plexus palsy, a nerve injury that can affect the shoulder as babies are born through the birth canal," she said. About 1.5 in 1,000 infants are born with a brachial plexus injury, suggests a recent study review published in Seminars in Perinatology. When shoulder muscles are stripped from their associated nerves, the tendon-to-bone attachments don't form properly, which can affect a child's shoulder health for a lifetime, said Killian. The findings from this research project may also have applications to rotator cuff injuries in adults.

Enthesis tissue mature with muscle contraction, so Killian is pioneering new experimental approaches to induce controlled muscle activity during growth. To do this, she is using optogenetics, a technique that utilizes light to cause activatable cells, likes neurons and myocytes, to depolarize and contract with exposure to blue light.

"This is novel because now, instead of unloading the muscle, we can overload the muscle, even if it's denervated, and potentially reverse the effects of brachial plexus injuries," Killian said.

Killian will study changes in the cell response to loading and will examine the structural changes to the shoulder joint using 3-D X-ray microcomputed tomography (microCT). Her laboratory will also measure functional changes of the attachments using biomechanical testing.

UD's microCT resources through the Delaware Rehabilitation Institute and Center for Brain and Biomedical Imaging, supported by the National Institutes of Health, the state of Delaware, and the Unidel Foundation, will help Killian complete this project. She also works with colleagues in the Department of Kinesiology and Applied Physiology.

Biomedical engineering students learned about how dissimilar tissues in our bodies attach in a course offered this past fall called Structural Interfaces in Biology. This course, developed at UD by Killian, covers how materials integrate and attach in biological systems, from tendon-to-bone attachments to the way gecko feet attach to smooth surfaces.

Provided by University of Delaware