High-speed Video Capture of Anterior Cruciate Ligament Tear

Devon T. SMITH¹, Steven L. COOK¹
Michael GILLESPIE¹, Houston C. REYNOLDS², Kimberly A. STEVENS¹, and Jonathan J. WISCO¹²
¹Brigham Young University, Provo, UT 84602, USA; ²University of Utah School of Medicine, Salt Lake City, UT 84132, USA.

Introduction: We filmed scalpel-induced tears of human and porcine anterior cruciate ligaments (ACL) using a high-speed camera. The porcine ACL is routinely used as an animal model of ex vivo tear dynamics for the human ACL, but may not be a fully accurate in situ model.

Materials and Methods: We dissected and stained three opportunity human specimens, as well as three porcine specimens, to expose the ACL. The femur was attached in a supine position to a platform on a table surface, the knee joint was flexed at 90 degrees with the tibia hanging vertically, and a 5-lb. weight was attached to the tibia in order to induce tension on the ACL. The ACL was then cut posteriorly with a scalpel, while a high speed video camera recorded the unraveling of the anteromedial (AM) and posterolateral (PL) bundle fibers.

Results: At the initiation of the human ACL tears, there was a consistent, subtle release of tension in a small proportion of fibers viewed as a ripple through the AM bundle. The tear pattern revealed that the PL bundle acts as a posterior post, with the AM bundle wrapping tightly around it. In contrast, the porcine bundles are arranged distinctly from one another, with a noticeable, but slight gap in between. This arrangement becomes more apparent just before tearing. The PL bundle immediately becomes taut, while the AM bundle stays lax. We also observed that the PL bundle was notably shorter than the AM bundle. Unlike with the human ACL, the porcine ACL bundles tore independently.

Conclusion: Although the bundles in both species unravel as a result of an induced tear under tension, our studies show that the in situ tear dynamics of the two species are remarkably different. In particular, the porcine PL bundle acts almost as an independent ligament and may provide more stability. Attempts to reconstruct the ACL in patients might benefit if two bundle ligament, rather than that of a single bundle, was utilized.