

MECHANICAL PROPERTIES OF PEDIATRIC ACL, PCL AND THE QUADRICEPS TENDON GRAFTS

Mark Sanchez, BS¹, Anshal Gupta, MS¹, Hunter Storaci, MS¹, Matt Rohde, BS¹, Seth Sherman, MD¹, Henry Ellis, Marc Tompkins, Phil Wilson, Dan Green, Ted Ganley, MD², Kevin Shea, MD¹

¹Department of Orthopedic Surgery, Stanford University, Stanford, California, USA

²Department of Orthopedic Surgery, Children's Hospital of Philadelphia, Philadelphia, USA

Background: ACL injury is very common in pediatric subjects, and PCL injury is increasingly recognized. Substantial research about the mechanical properties of adult knee ligaments exists, but comparatively little is known about the pediatric knee. Choosing a graft for ligament reconstruction in pediatric patients is limited by the lack of knowledge of the mechanical properties of those ligaments and potential graft options in the skeletally immature.

Purpose: Describe the mechanical properties of the pediatric ACL, PCL and the quadriceps tendon (QT).

Methods: Skeletally immature fresh frozen whole knees from 18 human cadavers (mean specimen age = 10.4 years) were thawed and the ligaments grossly dissected with bone block attachments. ACL and PCL specimens were tested as a single unit. The QT was tested as a 1cm wide column from the center of the tendon. Each specimen was secured in an MTS machine and underwent a tensile loading protocol to measure ultimate tensile strength, ultimate tensile strain, and linear modulus.

Results: The ACL exhibited ultimate tensile strength (7.9 ± 3.4 MPa), ultimate tensile strain ($53.7 \pm 22.5\%$), and linear modulus (33.3 ± 23.5 MPa) that were similar to the PCL (9.8 ± 6.6 MPa, $48.6 \pm 22.1\%$, and 47.9 ± 53.5 MPa, respectively). The QT demonstrated ultimate tensile strength of 6.1 ± 2.5 MPa, ultimate tensile strain of $35.0 \pm 9.4\%$, and a linear modulus of 36.5 ± 20.5 MPa.

Conclusion: The QT demonstrated lower ultimate tensile strength than the ACL and PCL, with a linear modulus that was greater than the ACL, but less than the PCL. Furthermore, the QT demonstrated lower values for ultimate tensile strength and linear modulus than the LCL and MCL. The QT may serve as a reasonable substitute for native ACL and PCL reconstruction due to similar ultimate tensile strengths and linear moduli.