



## Human Motion Lab Update

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Patient movement biomechanics that were once challenging to characterize, can now be accurately quantified in the Human Motion Lab at Penn Medicine. Located within the clinics of the Department of Orthopaedic Surgery, the Human Motion Lab's mission is simple: support decision making with objective and quantitative measurements of patient biomechanics. The 1,200 square foot lab is fully instrumented with motion capture, strength testing, muscle analysis, and ultrasonography equipment to study a wide array of musculoskeletal pathologies. These resources allow our researchers to work closely with musculoskeletal providers to identify key indicators of injury and treatment outcomes.

The Human Motion Lab has active projects with promising young clinicians and researchers at Penn Medicine. In collaboration with the Human Motion Lab, several projects were developed into grant applications and have secured funds:

- Dr. Josh Baxter—'The effects of tendinopathy on Achilles tendon biomechanics'
- Dr. Josh Baxter—'Applying machine learning algorithms to predict tendon health using ultrasound imaging'
- Dr. Kathryn O'Connor—'Correlating tendon diastasis with functional outcomes in acute Achilles tendon ruptures'
- Dr. Ben Gray—Feasibility of a low-cost motion capture device for clinical evaluation
- Dr. Ellen Casey—An *in vivo* longitudinal evaluation of the impact of oral contraceptives on connective tissue and neuromuscular control

Musculoskeletal models and cadaveric experiments are used in concert with measurements of human motion and tissue structure to more rigorously test research questions. Using simple computational models of the human body, we can perform virtual experiments to test the expected

effects of changing musculoskeletal parameters on function. In close collaboration with Dr. Michael Hast, Director of the Biedermann Lab for Orthopaedic Research, we have also combined *in vitro* data with *in vivo* data capture in the Human Motion Lab. Having such a strong collaboration with an expert in cadaveric models of the musculoskeletal system has advanced the scope and rigor of many of our research projects.

In addition to researching musculoskeletal injuries and pathologies, the Human Motion Lab has been cultivating relationships with Penn Athletics and other organizations in the Philadelphia area to provide objective and quantitative assessments of player health and function. While most patients treated at Penn Medicine are not elite athletes, understanding how these athletes stay healthy can provide new and unique insights into musculoskeletal pathology and injuries. These pursuits dovetail with our research goals of linking function with tissue structure and movement patterns. A recent study on a group of Penn Athletics distance runners found that these runners have structurally different Achilles tendons when measured using ultrasound imaging, which may be a protective adaptation to the increased tendon loading experienced throughout the rigors of training. Fortunately, the tendon structure is stable throughout the season, suggesting that once habituated to training loads, tendon health is quite stable. These findings also suggest that deviations in ultrasound measurements may be a warning flag of tendon pathology.

The Human Motion Lab is focused on establishing itself as a leader in the field of Achilles tendon health. Using motion capture, ultrasonography imaging, and musculoskeletal modelling we are beginning to explain the biomechanical factors that explain functional outcomes in these patient cohorts. With strong collaborations around the Department of Orthopaedic Surgery, we are excited for the future of the Human Motion Lab.