The Biedermann Lab for Orthopaedic Research

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Since opening in 2015, the Biedermann Lab for Orthopaedic Research has developed a substantial body of work involving biomechanical characterization of human tissue and orthopaedic implants. Research from within the Lab spans a wide variety of orthopaedic injuries and often involves multidisciplinary methods of investigation. By combining expertise in mechanical testing, motion analysis, and computational modeling, the Lab primarily seeks to provide comprehensive assessments of interactions between implants and their musculoskeletal environment. Over the last calendar year, the Lab has presented 14 abstracts at national meetings and published 10 full-length manuscripts. Topics have included trauma implant performance, osteoporotic fracture fixation, ligament biomechanics, and orthopaedic applications for additive manufacturing

The Biedermann Lab has recently partnered with several industrial sponsors in an effort to elucidate the relationships between trauma implant designs, construct biomechanics, and clinical outcomes. Studies have demonstrated the importance of implant design and surgical technique. For example, it was found that two screws provided increased stability in talonavicular arthrodesis in comparison to a plate with an integrated compression screw (study supported by Stryker Orthopaedics). Separately, it was found that Nitinol staple augmentation in clavicle fracture repair may improve healing in comparison to traditional plating techniques (supported by DePuy Synthes). Interestingly, these biomechanical studies continue to reinforce a common theme of our research: synthetic models do not faithfully recapitulate the failure mechanisms of cadaveric, particularly osteoporotic, bone. In the upcoming year, the Lab is excited to pursue more funded biomechanical experiments with DePuy Synthes, Acumed, and Integra LifeSciences.

The Lab has an established track record of internal and external academic collaborations, and that trend continued over the last year. The Biedermann Lab has an ongoing relationship with Josh Baxter and the Human Motion Lab here at the University of Pennsylvania. Most recently, the two labs conducted an AOFAS-sponsored study focused on quantitative ultrasound examination of cyclically fatigued cadaveric Achilles tendons. It was found that mean echogenicity may be a promising marker for evaluating fatigue damage in these tendons and could be readily incorporated into clinical predictive models for tendon injury. The Lab's partnership with Surena Namdari at the Rothman Institute also continued. This team developed a computational shoulder model that assesses

Instron machine set-up at the Biedermann Lab for Orthopaedic Research

relationships between greater tuberosity avulsions and range of motion restrictions. Most recently, the Biedermann Lab formed a new collaboration with Hannah Dailey's lab at Lehigh University. The two labs aim to explore relevant fracture-based questions using a combination of benchtop tests and finite-element models. Recently, the group presented an abstract at the 2020 ORS meeting which examined the sensitivity of specimen malalignments in benchtop biomechanical testing.

Additive manufacturing has become a major interest the Biedermann Lab. This was recently highlighted by our work on 3D printed fracture models for resident education, which was selected as a finalist for a New Investigator Recognition Award at the 2020 Orthopaedic Research Society conference. This Bach Fund sponsored study showed that providing resident physicians with preoperative 3D models of bone fractures significantly improved performance within the operating room. In this arena, the Lab has teamed with Drs. Guha Manogharan and Gregory Lewis at the Pennsylvania State University and recent work has resulted in four full-length publications. Most recently, the team secured a grant from the PA Manufacturing Fellows Initiative, related to the design and manufacture of patient-specific, additively manufactured rib implants.

The team at the Biedermann Lab is excited about the future of the Lab, as we feel that that our research continues to have a direct impact on clinical orthopaedic practice. Importantly, we appreciate the generous donations from the Biedermann family, which makes the aforementioned research possible.