RUSH

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Advancement of Medicine

I direct the Computational Biomechanics Lab in the Department of Orthopaedic Surgery at Rush. We are regarded as one of the top groups nationally in total joint replacement computer modeling research. We study the main long-term problem associated with all joint replacements: the wear and tear of implant materials. Wear can lead to mechanical and biological failure due to the body's reaction to wear products. Our federally-funded projects in total joint replacement research aim to develop and improve preclinical testing methods to predict how long total joint replacements will last in the body and to identify design or material changes that improve their longevity. The ultimate goal is "one implant for life." With our National Institutes of Health studies, this endowment and top-notch clinical partnerships at Rush, we are moving closer to this goal.

Support from this endowment has also enabled the laboratory to expand its research into joint preservation through a clinical and basic research partnership with **Adam Yanke, MD, PhD**. We continue to investigate problems with the patellofemoral joint, the joint between the kneecap and the end of the thigh bone at the front of the knee. Problems of this joint include patellofemoral pain and instability. Patellofemoral pain occurs at the front of the knee joint, and it often worsens when descending stairs, rising from a chair or sitting for extended periods of time. Patellofemoral instability occurs when the kneecap dislocates from the knee joint or moves in and out of the groove at the end of the thigh bone. Some patients with patellofemoral instability may need a surgical intervention such as a tibial tubercle osteotomy, or TTO. TTO is used to move the point of action of the quadriceps to reduce force through the kneecap or improve tracking within the groove. We are investigating the optimal position for TTO given complex patient anatomy using computer modeling.

Computer modeling is ideal for this problem because it enables a wide range of surgical simulations that would otherwise be impossible to test on the same patient.

Research

This endowment has enabled me to continue research on the patellofemoral joint and made me competitive for NIH funding in this area. It also allowed me to hire a talented student full-time after she successfully defended her master's degree in biomedical engineering. The endowment also supported software used by research groups of four other faculty members.

Select Presentations

- **Lundberg HJ.** Multidisciplinary Teams: Essential for Achieving Translational Impact with Finite Element Models, Annual Meeting of the Orthopaedic Research Society, February 7-11, 2025, Phoenix, Arizona.

Abstract Presentations

- Reddy Koppala B, Godoy M, Hochstatter J, Wright JL, Levine BR, Pourzal R, **Lundberg HJ.** "Are Ceramic Head Tapers Interchangeable on Stem Tapers from Multiple Manufacturers? A Retrieval and Computational Analysis." Poster Presentation, Orthopaedic Research Society 2025 Annual Meeting, February 7-11, 2025, Phoenix, Arizona.
- Turinske T, Phillips A, Acheampong K, Mell S, Yanke AB, **Lundberg HJ.** "An In-Silico Method of Evaluating the Effect of Tibial Tubercle Osteotomy on Patellofemoral Contact Mechanics." Poster Presentation, Orthopaedic Research Society 2025 Annual Meeting, February 7-11, 2025, Phoenix, Arizona.
- Levine B, Jacobs J, Pourzal R, **Lundberg H,** Hall D, Van Citters D, Asher D, Wright J. "Reasons for Failure and Wear In TKA With Conventional and Highly Crosslinked Polyethylene Tibial Inserts Retrieved In The Mid- Long-Term." Poster Presentation, Annual Meeting of the American Association of Orthopaedic Surgeons, March 10, 2025, San Diego, California.
- Godoy M, Liu S, Asher D, Jacobs JJ, Terhune EB, **Lundberg HJ**, Hall DJ, Pourzal R. "Inflammatory Responses To Fine Wear Particles From Conventional And Highly Crosslinked

Polyethylene Inserts In Total Knee Arthroplasty." Podium Presentation, International Society for Technology in Arthroplasty 2025 Annual Meeting, September 18-21, 2025, Rome, Italy.

- Paris I, Solberg P, Pourzal R, **Lundberg HJ**, Van Citters DW. "Finite Element Analysis Of Lipid Uptake in UHMWPE Under Mechanical Loading: Combined Numerical And Experimental Study." Podium Presentation, International Society for Technology in Arthroplasty 2025 Annual Meeting, September 18-21, 2025, Rome, Italy.
- Haboba Nebel CS, Turinske T, Augustin EJ, Acheampong K, Phillips AR, Haneberg EC, **Lundberg HJ**, Yanke AB. "Validation Of Finite Element Model Prediction Of Patellofemoral Joint Mechanics." Poster Presentation, International Cartilage Regeneration & Joint Preservation Society Annual Meeting, October 11, 2025, Boston, Massachusetts.
- Augustin EJ, Acheampong KK, Turinske T, Haboba Nebel CS, Moran TE, **Lundberg H**, Yanke AB. "In-silico Analysis Of Sagittal Tibial Tubercle-trochlear Groove Distance Effect On Patellofemoral Pressures Post-TTO." Poster Presentation, International Cartilage Regeneration & Joint Preservation Society Annual Meeting, October 11, 2025, Boston, Massachusetts.
- Levine, BR, **Lundberg HJ**, Gustafson JA, Terhune EB, Turinske T, Mell S. "The Influence of Surgeon Impact Force, Material, and Angular Mismatch in THA Contact Mechanics." Poster Presentation, Annual Meeting of the American Association of Hip and Knee Surgeons, October 25, 2025, Grapevine, Texas.

The Year Ahead: 2026 and Beyond

I will prioritize resubmission of two federal grants that I received feedback on earlier this year. Over the course of the year, endowment funds were used to strengthen preliminary data towards these applications.

With Gratitude

Thank you for your support. Over the past year, this endowment has enabled me to meaningfully contribute to our department's educational and research missions, including mentoring trainees,

advancing interdisciplinary collaborations, sustaining high-quality scholarly output and continuing to raise our visibility at national conferences. The endowment not only directly supports my work but also provides essential research infrastructure — such as computational resources — critical to the continued growth of computational biomechanics research at Rush.