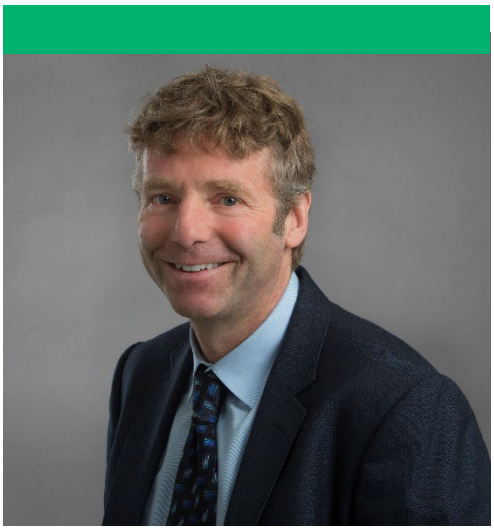
RUSH

Markus A. Wimmer, PhD

The Grainger Director of the Rush Arthritis and Orthopedics Institute



Advancement of Medicine

In 2023, your generosity supported two major studies which investigated periprosthetic infection and the mechanics of cartilage deterioration. Also, we brought the study related to COVID-19 to an end and submitted the results for publication.

Periprosthetic joint infection, or PJI, has become the leading cause of joint replacement failure: 20-30% of the replacement procedures are due to infection. However, only 50% of the revision cases are treated successfully, and the five-year mortality can be greater than 25%. Hence, there is a real need to address the issue. With your help, we developed a mouse model to study this infection at Rush University, which is now being used to test prevention and treatment techniques. We are currently working on two strategies. One strategy resulted in cooperation with a start-up called Clarametyx to test their antibody as a method to prevent and treat bacteria in a periprosthetic setting. While the antibody has been developed, it is our intellectual property to attach to an implant, which has shown very promising pilot results in our mouse model.

For both strategies, patents have been filed with Rush University Medical Center. Also, there is an R21-study pending with the National Institutes of Health, or NIH. My former postdoctoral student, **John L. Hamilton, MD, PhD**, was recognized as a New Investigator Recognition Award finalist to present our data at the Orthopaedic Research Meeting in February. This is a highly competitive recognition.

The second project focused on osteoarthritis, or OA. Osteoarthritis is a debilitating disease that affects over 500 million people worldwide, without a disease modifying drug available. In this project, we have been interested if the ionic phase in cartilage may influence its tissue properties. For a series of tests, we have teamed up with Tom Schmid, PhD, a former Rush biochemist, to investigate

whether a reduction of divalent ions could deteriorate the mechanical competence of the tissue. Using our home-build wear testing device, we found that the cartilage's wear properties clearly deteriorate in the absence of divalent ions. We were also able to show that the tissue becomes softer and its surface strength to avoid rupture decreases by 20 percent. Softer tissue properties and a disrupted superficial surface have been described as OA hallmarks. Hence, we believe that this is an important new discovery that may stimulate future research beyond the boundaries of Rush.

Research

Funds from the Grainger endowment supported the work of several individuals who contributed to our ongoing studies as well as a variety of projects for research consumables. Your funds allowed us to purchase a friction module for our existing rheometer that will be used in the above-described cartilage study. In addition, your generosity also supported statistical consultants to bring the COVID-19 study to an end. Finally, your support enabled several team members to attend conferences where they presented our research.

Grants

Our activities regarding COVID-19 led to an award by the Institute of Translational Medicine in Chicago. This award allowed us to access the U.S. National COVID Cohort Collaborative database and validate our previous findings at Rush.

With regard to our PJI study, we are close to signing an industry grant with Clarametyx, and we are waiting on the NIH funding decision on a R21 application which ranked in the 10th percentile upon first submission. Both grants will help to enhance our activities.

No grant application has been submitted regarding the influence of ions on the mechanical competence of cartilage. This will be the next undertaking after our pilot data has been submitted for publication.

Presentations

- March 2023: Invited Speaker at the Gordon Research Conference on Cartilage Biology and Pathology, "The ionic phase in cartilage and its influence on tissue tribology."
- September 2023: Invited Speaker (virtual) at the Biotribology Forum, Fukuoka, Japan on "Articular cartilage shear and tensile properties in the context of tissue wear."

- November 2023: Course Faculty 2023 AAHKS Research Course, Dallas, TX on “Successful collaborations in engineering research.”
- January 2024: Invited Speaker ‘American Corner Lectures’ (co-sponsored by the US Embassy) at the NOVA School of Science and Technology, Lisbon, Portugal on “Backside wear of tibial polyethylene components is affected by gait pattern: A knee simulator study using motion analysis as input.”
- January 2024: Guest Lecture at the Instituto Superior Técnico, Lisbon, Portugal on “Articular cartilage shear & tensile properties in the context of tissue wear.”
- January 2024: Invited Lecture, AO Research Institute, Davos, Switzerland “The ionic phase in cartilage and its influence on tissue properties.”

Publication Highlights — Abbreviated

- “Topography rules the ultra-mild wear regime under boundary lubricated gross-slip fretting corrosion,” *Wear* (2023).
- “The gross slip fretting corrosion mechanisms of biomedical ceramic-metal couples,” *Biotribology* (2023).
- “Electrophoretic deposition of gentamicin and chitosan into titanium nanotubes to target periprosthetic joint infection,” *Applied Biomaterials* (2023).
- “Development of lubrication film and influence on friction in a total knee replacement during a gait cycle,” *Tribiology International* (2023).
- “Real-time musical feedback from pressure-sensing insoles for asymmetric gait retraining,” *Osteoarthritis and Cartilage* (2023).

The Year Ahead: 2024 and Beyond

We will turn over this chair to **Joshua Jacobs, MD**, the former chairman of the Department of Orthopedic Surgery. Dr. Jacobs has been appointed by the dean to lead a new Institute of Arthritis and Orthopedics. Your generosity will support his activities.

RUSH

With Gratitude

Thank you for giving me the opportunity to advance orthopedic research at Rush since 2017. Without your help, a periprosthetic infection theme could not have been established at Rush. Within a relatively short timeframe, we have become contenders in the field and are close to federal funding. This is a big achievement.

I have similar big hopes for the cartilage research that was supported by this chair and earlier through a grant of the Galante Family Foundation. Clearly, the direction we took is unique and differs from other current approaches to find a cure for OA. I wish the next chair holder, Dr. Jacobs, a successful continuation.