Correlative microscale mapping of human meniscus biomechanics and biochemistry by AFM micro-indentation and MALDI-FTICR mass spectrometry imaging

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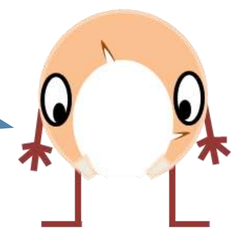
[1]TU Wien, Vienna, Austria

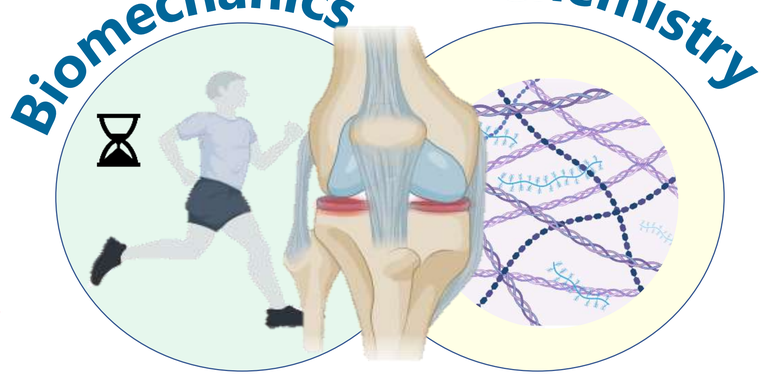
[2]Medical University of Vienna, Vienna, Austria

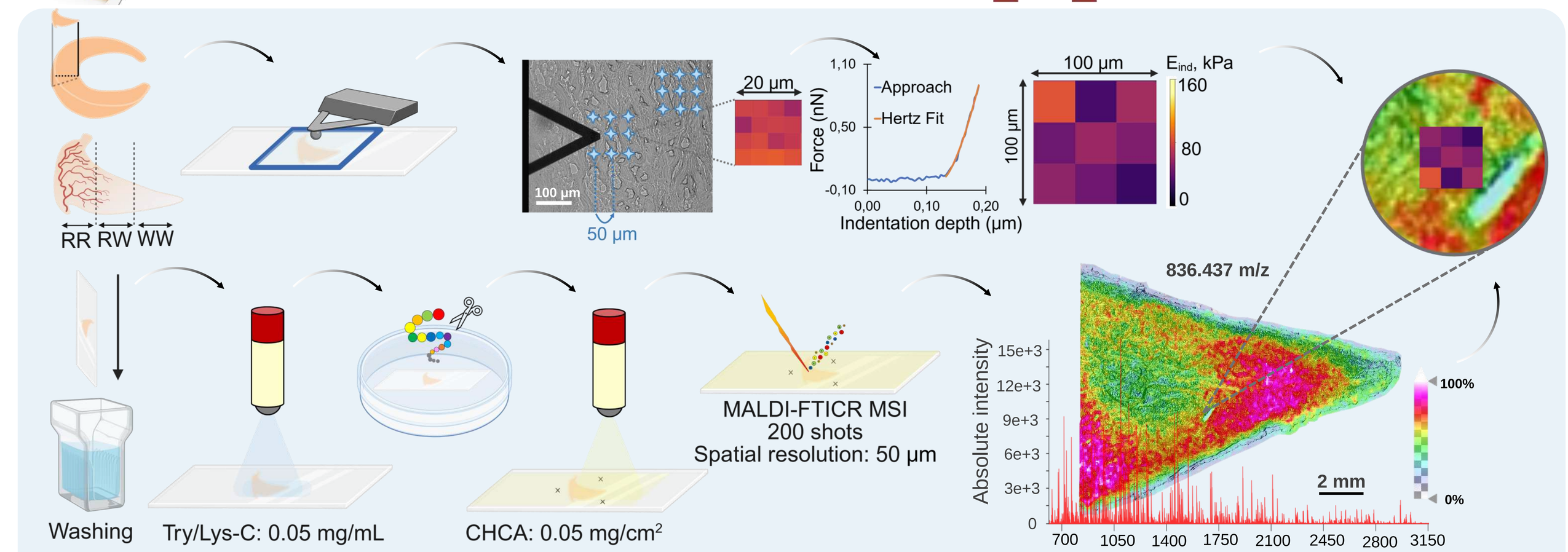
Meniscus degeneration – the cause of chronic pain



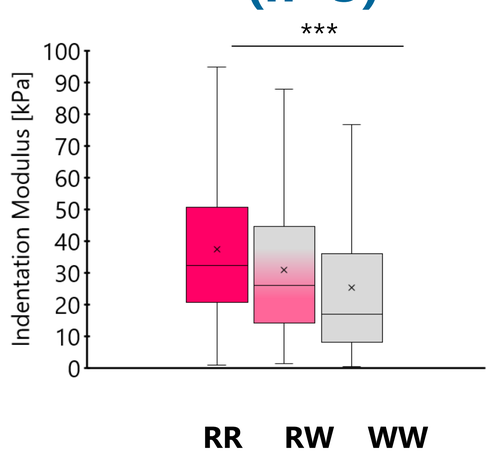
I lost my volume and can not distribute the load in knee joint well. Now I am a risk factor of knee arthritis! If only it were possible to detect the first markers of my degeneration…



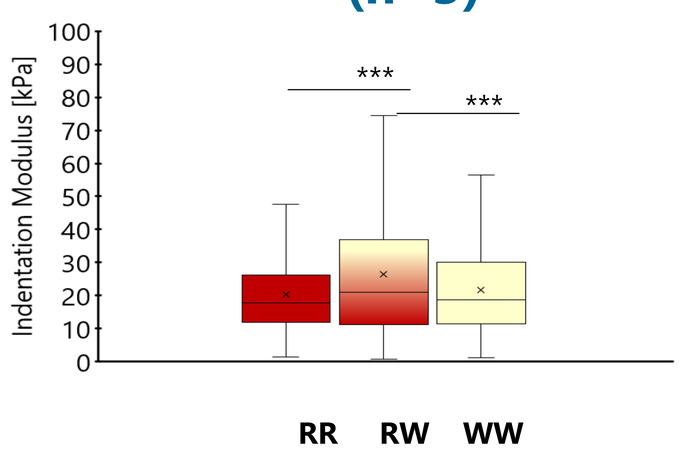


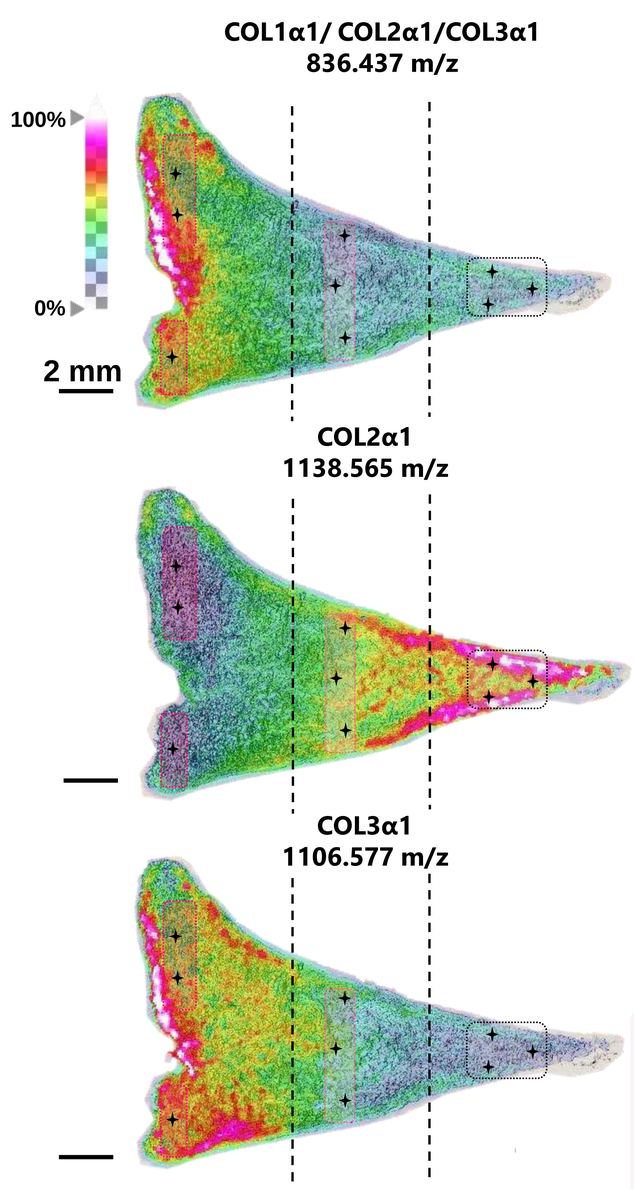


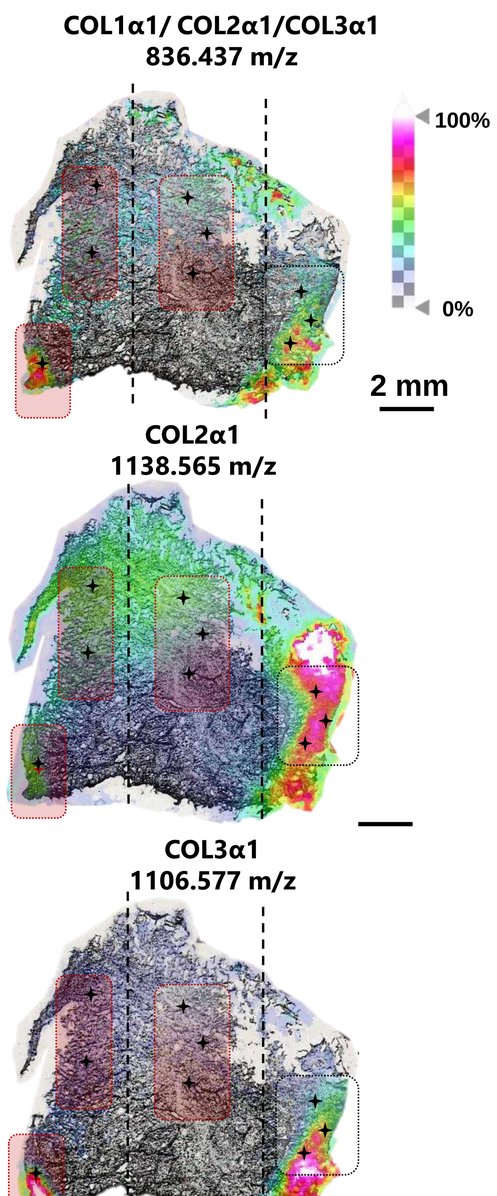
Healthy aged menisci (n=3)



Osteoarthritic menisci (n=3)

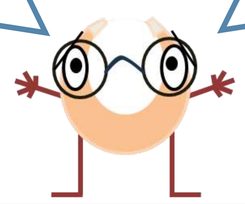






Healthy aged menisci maintain a native stiffness gradient and organized collagen architecture.

Osteoarthritic menisci display reduced stiffness, disrupted gradients, and heterogeneous matrix composition.



Conclusion

- ✓ **Combined AFM and MALDI MSI** on the same meniscus sections
- ✓ **Mapped stiffness and collagen distribution** across three regions
- ✓ Found **region-specific differences in elasticity and peptide signals** from main components
- ✓ Revealed **links between biomechanics and molecular composition**

Outlook: The approach could be extended by integrating MRI and histology for multi-scale tissue analysis and, in the long run, may support early detection of meniscus degeneration.

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TU WIEN TECHNISCHE UNIVERSITÄT WIEN

ILSB Institut für Leichtbau und Struktur-Biomechanik

MSBP ANALYSIS

MEDICAL UNIVERSITY OF VIENNA