OARSI Collaborative Scholarship Report:

Effects of Exercise on Cartilage Degeneration, Subchondral Bone Remodelling, and Metabolic Pathways in Anterior Cruciate Ligament Transection-Induced Osteoarthritis Rat Model

1. Introduction

Osteoarthritis (OA) is a significant cause of morbidity, particularly in the elderly population. The disease is characterized by progressive cartilage degradation and subchondral bone lesions (SBL), which often remain undetected using conventional imaging techniques until it is too late for effective intervention. Developing sensitive diagnostic tools such as **high-resolution peripheral quantitative computed tomography (HR-pQCT)** is essential for early detection and quantitative analysis.

Moderate physical activity (MPA) has been hypothesized as a possible intervention for delaying OA progression, but its effectiveness remains uncertain. This study aims to evaluate early microstructural and biochemical changes in the **anterior cruciate ligament transection (ACLT) rat model** and analyze the role of MPA in subchondral bone and cartilage integrity.

2. Objectives

The study aims to:

1. Identify early subchondral bone microstructural and cartilage changes in ACLT-induced OA rats.
2. Evaluate the effects of moderate physical activity on subchondral bone and cartilage in early OA.
3. Investigate miRNA interactions and their role in regulating homeostatic pathways in OA ACLT rats.

3. Methodology - Experimental Design

Rats were divided into four groups:

- Healthy control rats
- ACLT-induced OA rats
- Healthy rats subjected to exercise
- ACLT-induced OA rats subjected to exercise

Outcome Analyses:

- Microstructural Imaging – HR-pQCT for subchondral bone lesion detection
- Histology – Cartilage integrity assessment
- Biochemical Analysis – miRNA expression profiling

4. Research Training Under Prof. Dr. Yang Xia

During my training with **Prof. Dr. Yang Xia**, I had the privilege of working with state-of-the-art imaging technologies used for pre-clinical osteoarthritis research. His generosity in

sharing his book, research papers, and souvenirs has left a lasting impact (Fig. 1). His mentorship, encouragement, and constructive feedback have significantly contributed to my academic and personal growth.

Techniques and Equipment Learned

- **µMRI** – Bruker AVANCE IIIHD (7 Tesla superconducting magnet, ParaVision 6, 10-20µm transverse resolution)
- **Polarized Light Microscopy (PLM)** – Leica DM microscope system with Abrio imaging platform (from a fraction of µm to tens of µm resolution)
- **Micro-CT (µCT)** – Skyscan 1174 with a high spatial resolution (6-30 µm isotropic resolution)
- **Fourier-transform Infrared (FTIR) microscopic spectroscopic imaging** – PerkinElmer Spotlight 300 for the analysis of molecular motions (6.25µm transverse resolution)
- **In Situ Mechanical Imaging** – *In situ* cartilage compression and load sensing using a Nikon inverted microscope system
- **Biomechanics Testing** – EnduraTec ELF3200 for static and dynamic mechanical assessments

These advanced tools provided crucial insights into OA progression and potential interventions.

5. Acknowledgments

I sincerely thank Prof. Dr. Yang Xia, a Distinguished Professor, a Medical Physicist at Oakland University, and one of the world's top 2% scientists (as recognized by Stanford University and Elsevier Data Repository), for his generosity and guidance. His expertise in pre-clinical imaging biomarkers for osteoarthritis has been invaluable. A special appreciation to the students in Xia‘s Lab (Farid, Syeda, Amanveer, Sarah, and Aaron), who introduced me to the laboratory equipment and shared their research expertise (Fig. 2).

6. Conclusion

The results of this study have potential clinical applications for early OA detection and intervention. I am grateful to the **OARSI Board and Research and Training Committee** for supporting this scholarship program, which has provided a highly enriching experience.

Lastly, I am excited to present some of our findings at the **2025 OARSI meeting in South Korea** and look forward to future collaborations.

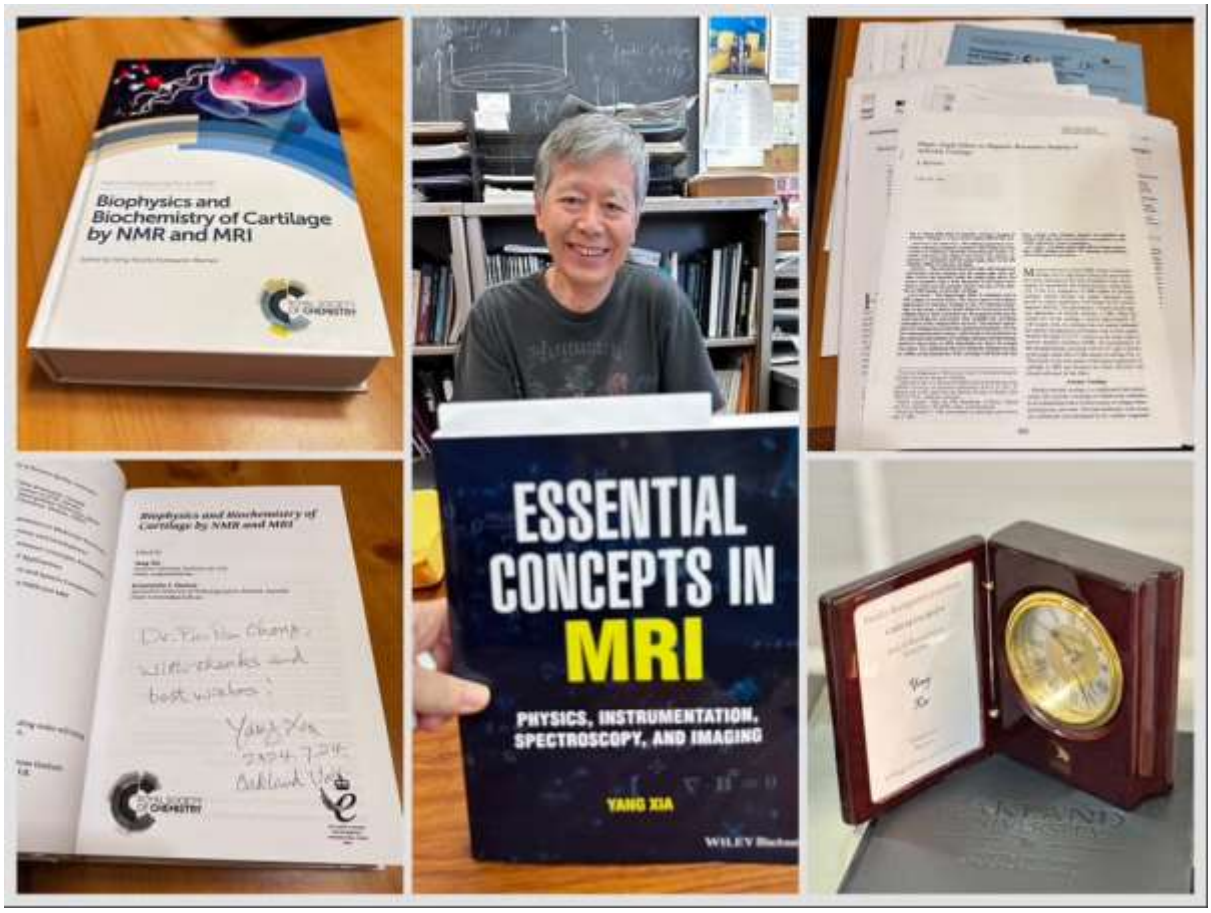

Figure 1: Prof. Dr. Yang Xia

Figure 2: Prof. Dr. Yang Xia, his team members, colleagues and laboratory facilities.

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