Comprehensive morphological characterisation of arthritis in animal models by micro-CT

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Comprehensive morphological characterisation of arthritis in animal models by micro-CT

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Project objectives:

This project aims to **develop a quantitative 3D imaging methodology (QIM)** for measurement and morphological analysis of osteoarthritic joints.

Scientific and technological objectives:

- Develop protocols for processing of intact animal joints for μCT: dissection, preservation, and staining of the tissues.
  ⇒ **Figure 1**
- Develop μCT protocols for quantitative morphometric characterisation of relevant bone and cartilage structures.
  ⇒ **Figure 2**
- Establish the correlation between μCT data with histomorphology analyses.
  ⇒ **Figure 3**
- Obtain a comprehensive 3D evaluation of macroscopic and microscopic changes in the morphometry and composition of the bone and cartilage components of the joint.
  ⇒ **Figure 4**

Business objectives:

- Training of clientele in protocols for processing of intact animal joints.
- Training of clientele in protocols for quantitative morphometric characterisation.
- Commercialisation of a software add-on to the spectrum of current possibilities in μCT imaging, i.e. new standards for quantitative imaging of OA.
- Validation and reference data packages for calibration of disease models.

Implementation & perspectives:

- Close collaboration with industry and academic partners provided a platform for creating new tools and add-ons for existing technologies by supplying:
  - an accurate and superior QIM relative to existing histological methods,
  - a precise and statistically powerful QIM for use in experimental settings.
- The analysis algorithms will be packed into existing software and sold to new customers with enhanced analysis options.

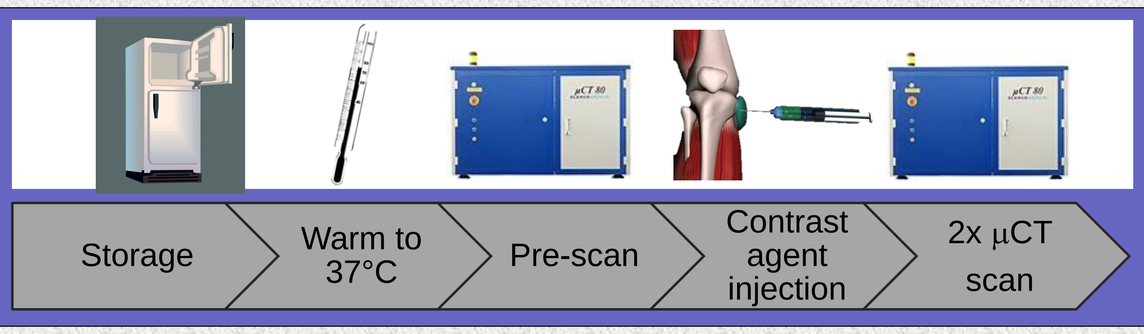


Figure 1: Protocol for sample processing prior to μCT scans.

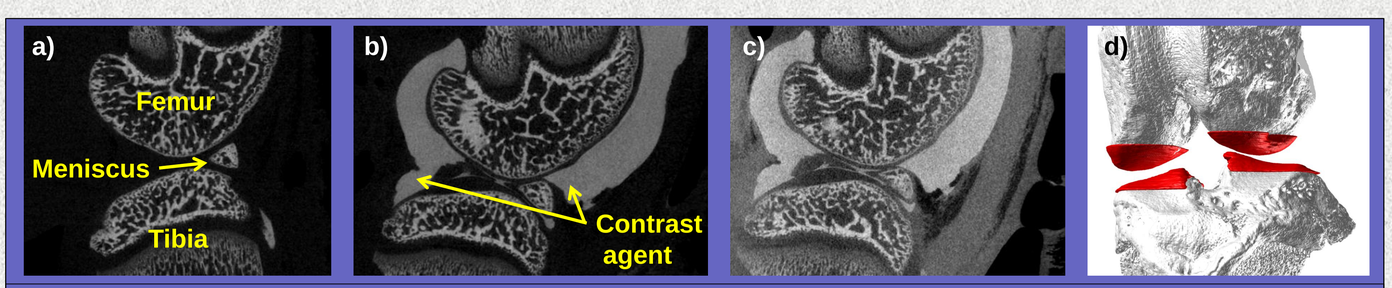


Figure 2: Morphometric characterisation of the joint tissues involves three scans: (a) an initial pre-scan, and (b-c) two scans with different contrast agents. The final segmented tissues can be seen in d, where bone is white and cartilage is red.

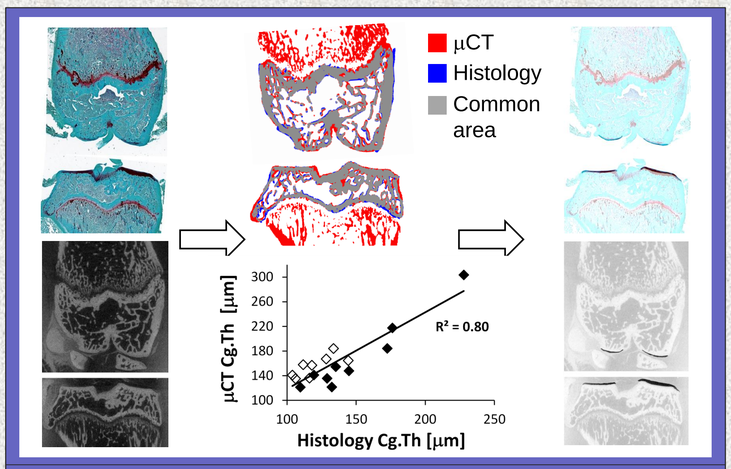
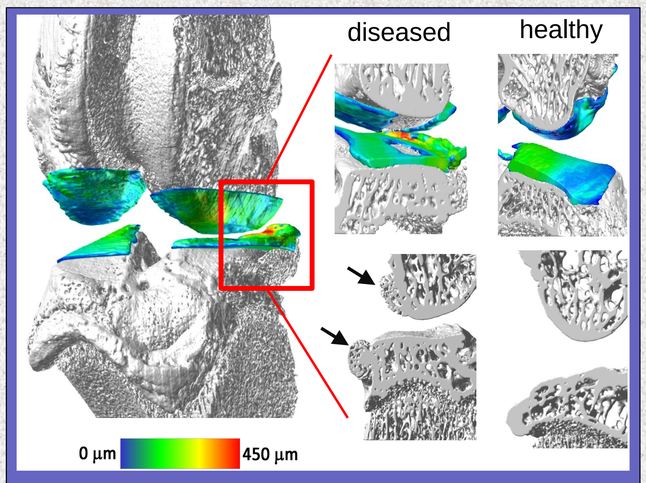
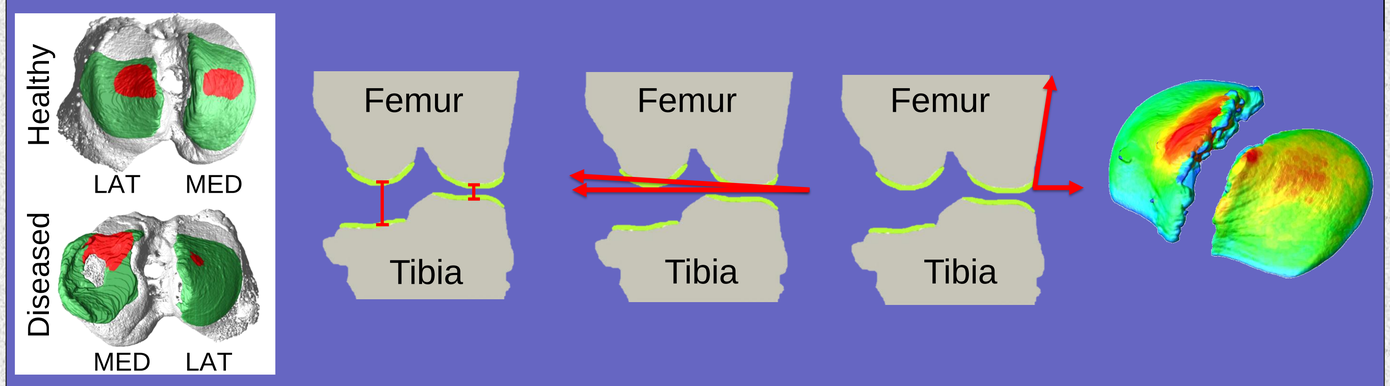


Figure 3: Correlation between μCT and histology of 2D cartilage thickness, Cg.Th,.



4 a) 3D reconstruction of a rat knee joint.

4 b) Quantifying macro- and microscopic changes in OA joints: **the QIM**



CONTACT AREA: Changes in joint geometry alter loading conditions

JOINT SPACE: Distance changes with disease and affects joint geometry

VARUS-VALGUS TILT: Alignment changes between femur & tibia.

OSTEOPHYTE: Altered loading leads to bone remodelling.

3D CARTILAGE THICKNESS: OA progression leads to degeneration

Figure 4: Comprehensive 3D analyses of the tibio-femoral joint. a) The full 3D dataset allows investigation of cartilage degeneration and subchondral bone remodelling in any orientation, and (b) a selection of characteristic metrics used to describe OA.

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Project details:

Main applicant:	Department of Clinical Research University of Bern *PD. Dr. Dobrila Nesic*
Industrial partner:	SCANCO Medical AG *Dr. Bruno Koller*
Start date: April 2009	**Duration:** 42 months