The role of dynamic mechanical behavior of altered collagen network under loading to OA state-dependent cartilage degradation: combined in vitro and in silico study

A Data Management Plan created using DMPonline.be

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Project abstract:

Osteoarthritis (OA) is the most common joint disease, which significantly impairs the life quality of affected patients with pain and mobility restriction. Consequently, it causes a high economic burden for both the individual and the society. Today, no successful preventions or interventions have been identified yet. It is however known that cartilage degeneration and loss of its unique mechanical properties is the hallmark of OA. A thorough identification of the mechanisms that drive cartilage degeneration is the foundation of intervention development in the future. Whereas the compositional changes and alternations in tissue-level mechanical properties induced by OA have been investigated, I hypothesize that the OA state-dependent changes in the mechanical behavior of specifically the collagen network, drive the alterations in tissue-level mechanism underlying cartilage degeneration. With this project, I will characterize the OA state-dependent dynamic mechanical properties of cartilage collagen fibrils based on non-destructive synchrotron-based small-angle X-ray diffraction (SAXD). I will then use this experimental information to develop OA state-dependent microstructure-informed adaptive in silico models to unravel the role of cartilage microstructures in OA and predict loading safe zones that prevent microstructural cartilage degeneration.

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1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		Please choose from the following options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
Histology Microscopies (WP1 &WP3)	Histology sections of human cartilage, and histology images generated with polarized light microscopy, digital densitometry and Fourier transform infrared spectroscopy	Generate new data	digital and physical	Experimental	.tiff, .png, and .jpg	<1TB	<4dm2
SAXD Images and Overall Deformation (WP1)	Small angle x-ray diffraction (SAXD) images of cartilage samples under loading, and overall deformation of cartilage under loading	Generate new data	digital	Experimental	.tiff, .png, and .jpg	<1TB	

Processed Mechanical Behavior (WP1)	mechanical behavior of cartilage tissue and microstructures calculated from SAXD images and overall deformation of the tissue	Generate new data	digital	experimental	.xlsx,.mat, .tiff, .png, and .jpg	<1GB	
Cartilage Plugs (WP1&WP3)	human cartilage plugs harvested from human hip joints. Stored for SAXD and/or histology microscopies	Generate new data	physical				<4dm2
Donor Information (WP1&WP3)	non-identifiable personal information of cartilage tissue donors, including biological sex, age at surgery and reason for surgery.	Generate new data	digital	observational	.xlsx	<100MB	
Cartilage Model (WP2)	cartilage 3D models and meshes created for finite element (FE) modeling	Generate new data	digital	Compiled/aggregated data	.ansa, .inp	<1GB	
FE Simulation (WP1&WP3)	FE simulation results of the cartilage explant with a user-defined material subroutine in Abaqus	Generate new data	digital	simulation data	.odb, .f, .for,.cae, .m	<5TB	
Codes	Users subroutine or codes written to generate the models or process data	Generate new data	digital	others	.py, .m, .mlx, .f, .for	<1GB	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

n/a

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- Yes, human subject data

In KU Leuven, we will receive human cartilage samples (surgical waste) and the anonymized data from the sample donor as part of an approved ethical evaluation by University Hospital Leuven (S61930) in WP1 and WP3. [dataset **Cartilage Plugs**, and **Donor Information**]
In UK, we will also receive experimental data collected from human cartilage and pseudonymized data of the tissue donor from our collaborator at Imperial College London in WP1.[dataset **Histology Microscopies**, **SAXD Images and Overall Deformation**, and **Donor Information**]

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- Yes

Personal data collected, regarding dataset **Donor Information**, will be fully anonymised. Only the following information will be kept for the research purpose

- biological sex
- age at the surgery
- reason for surgery

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- Yes

We will receive cartilage samples collected from surgical waste of total hip replacement surgery and psuedonymised data of the tissue donors from our collaborator at Imperial College London. A data transfer agreement is being drafted. IPR will be owned by both Imperial College London and KU Leuven.

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

The following documentation will be provided:

1. Table of content (excel file and .csv) with all project-related experiments including
   experiment number, date of implementation and name of the researcher who stored the experiment
2. Brief description of the goal of the experiment and related work package (word and .txt file)

3. Detailed protocol or link to an existing standard protocol (SOP) which will enable other researchers to repeat the experiment.
4. All data or link to another file with the (raw) data
5. If appropriate, illustrations of the data with legends and statistical analysis. In case that documentation is written or available in notebooks or stored on other files a link will be provided.

With the help of these documentations every authorized researcher will be able (1) to look up all the information of the performed experiments and (2) to repeat the experiments in the same way.

All data will be coded. This will consist of:

1. Experimental protocols: description on how the data is collected and generated (software, materials, set-up, settings (.docx) and how data are processed (software, protocol, guidelines, …) (.docx, read.me text files);
2. Measurement forms: notes during data collection (printed paper);
3. Raw experimental data: storage of original physical data and folders with original digital data in software-specific files;
4. Processed data: folder with digital data in the software-specific files, spreadsheets with results (.CSV, .xls);

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- No

For folder organization, a logical hierarchy with broader topics at a higher level within specific folders will be created. The folder names will be descriptive. File names will have a clear meaning and the following information will be included in the file names: project or experiment name (or an acronym of it), name of the researcher or author of the file (or initials), date/date range, type of data and version number of the file. Clear version numbers will be provided if several versions of data are kept.

Metadata will be provided as readme, word, excel or xml files, containing all settings and technical descriptions of the experiments and data processing workflows. A data dictionary or codebook will describe labels for all variables and codes, variables types, units of measurement and key identifiers for a data file. Standard operating procedures (SOPs), logbooks, lab protocols will be included. Explanatory comments in code or model script will be included.

3. Data storage & back-up during the research project

Where will the data be stored?

All datasets will be stored primarily in the researcher's laptop. All datasets **except** dataset **FE Simulation** will be uploading onto OneDrive account of KU Leuven, and the dataset **FE Simulation** will be kept on the shared J drive of our research unit. And All datasets will be backed up in an external hard drive upon the finish of each experiments or simulations.

How will the data be backed up?

All datasets **except** dataset **FE Simulation** will be uploading onto KU Leuven OneDrive account, and the dataset **FE Simulation** will be backed up on the shared J drive of our research unit. And All datasets will be backed up in an external hard drive upon the finish of each experiments or simulations. Upon the finish of the project, all datasets will be backed up again on the university's central server.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

- Yes

2TB is assigned on OneDrive for each KU Leuven employee. Sufficient J drive storage capacity has been purchased by the group through the KU Leuven ICTS center. An External hard drive of 4TB has been used for external backup. If additional external storage is needed, a second hard drive can be purchased through KU Leuven ICTS center.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

Data on OneDrive and shared J drive will be given access only to authorized researchers of the group. Data stored on external hard drive will be coded and the password will only be given to authorized researches.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

200 Euros is expected to purchase an external hard drive. The cost will be covered by the PI Prof. Ilse Jonkers.

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

All digital data, including all experimental data, compiled data, simulation data, and anonymized personal data will be stored for at least five years after the finish of the project. Physical data of histology sections [in dataset **Histology Microscopies**] and **cartilage plugs** will be discarded upon the finish of the project or the experiments to reduce storage space and cost.

Where will these data be archived (stored and curated for the long-term)?

The data will be stored on the KU Leuven shared drives, research group hard drives and KU Leuven data repository for long-term.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

€227.5 / year for storing data on the university server, and this will be covered by the PI Prof. Ilse Jonkers.

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in a restricted access repository (after approval, institutional access only, …)
- No (closed access)

Pseudonymized data transfer from our collaborator at Imperial College London in dataset **Donor Information** will not be shared or reused after/during the project. However, the fully anonymized personal data can be available. All other digital data can also be available in a restricted access repository, after deleting all links to donor personal information.

If access is restricted, please specify who will be able to access the data and under what conditions.

Researchers involved in this project will have access to the data. External researches can get access upon reasonable and specific request. Only uses for research purposes will be allowed and commercial reuse will be excluded.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- Yes, Intellectual Property Rights
- Yes, Ethical aspects

Pseudonymized data transfer from our collaborator at Imperial College London in dataset **Donor Information** will not be shared due to ethics. Other digital data can be shared after the publication of the research results for IP protections.

Where will the data be made available? If already known, please provide a repository per dataset or data type.

The data will be made available on KU Leuven RDR with restricted access.

When will the data be made available?

The data will be made available with restricted access upon the publication of associated research results and after sufficient anonymization.

Which data usage licenses are you going to provide? If none, please explain why.

Creative Commons Attribution-NonCommercial-ShareAlike (CC-BY-NC-SA) will be used to ban commercialization and request work based on the data to be released.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- Yes

What are the expected costs for data sharing? How will these costs be covered?

No costs are expected. If any occur, that will be covered by the requesting parties.

6. Responsibilities

Who will manage data documentation and metadata during the research project?

The PhD researcher Yixuan Zhang, under supervision of the promotor Prof. Dr. Ilse Jonkers, and co-promoter Dr. Seyed Ali Elahi..

Who will manage data storage and backup during the research project?

The PhD researcher Yixuan Zhang, under supervision of the promotor Prof. Dr. Ilse Jonkers, and co-promoter Dr. Seyed Ali Elahi..

Who will manage data preservation and sharing?

The PI Prof. Dr. Ilse Jonkers

Who will update and implement this DMP?

The PhD researcher Yixuan Zhang, under supervision of the promotor Prof. Dr. Ilse Jonkers, and co-promoter Dr. Seyed Ali Elahi..