Radboudumc

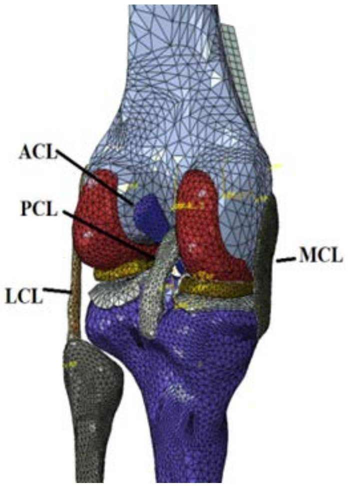
Orthopaedic Research Lab

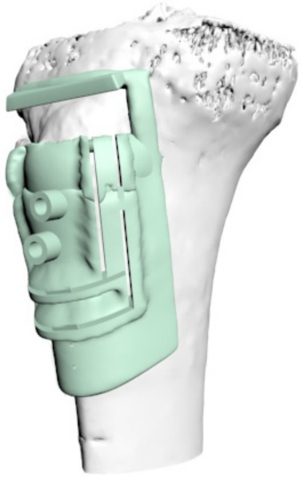
The Orthopaedic Research Laboratory (ORL) performs research in the field of orthopaedics.

The biomechanical section focusses on bone, soft tissues and on pre-clinical testing of implants.

We are specialized in mechanical testing, computational analyses, histological analyses and animal testing.

Our strength lies in combining these techniques, allowing for cross-validation and innovative research.





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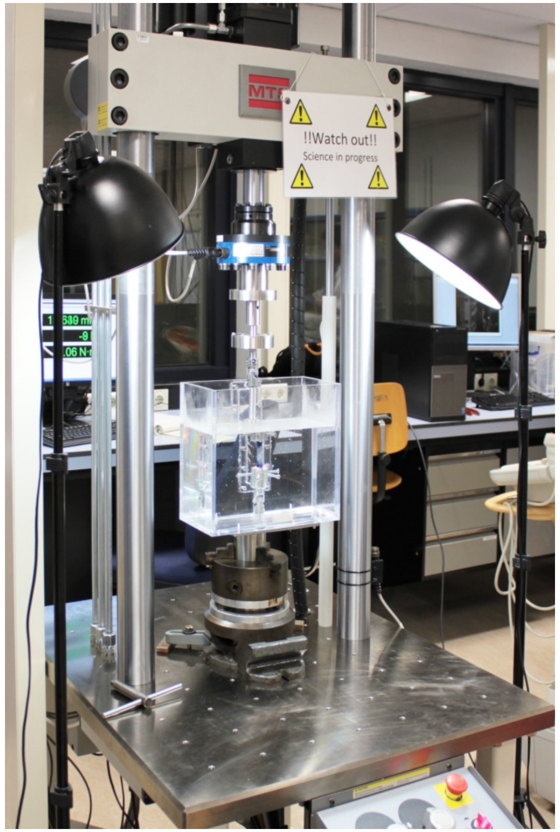
Next

We are

The ORL consists of a highly passionate and motivated team of experts with various backgrounds such as bioengineering, health sciences, medicine, epidemiology, histology, software engineering and image analyses. The lab is embedded in the orthopaedic department headed by Prof.dr. Marinus de Kleuver; the ORL is supervised by biomechanical engineer Prof. dr. ir. Nico Verdonschot.

Supporting equipment for Biomechanic testing



MTS hydraulic testing machine

The ORL has two fully calibrated MTS testing machines with loading ranges up to 15 Kn. In addition, one MTS machine has the capability to apply a torque up to 225 Nm.

We have capabilities to design dedicated experimental set-ups to assess strength, stability and fatigue properties of various materials and reconstructions. Reconstructions are often tested in combination with cadaveric materials which we obtain from the Anatomical department of the Radboudumc.

Testing conditions can vary from dry to simulated body fluids at 37 degrees centrigrade.

Bose Electroforce tester

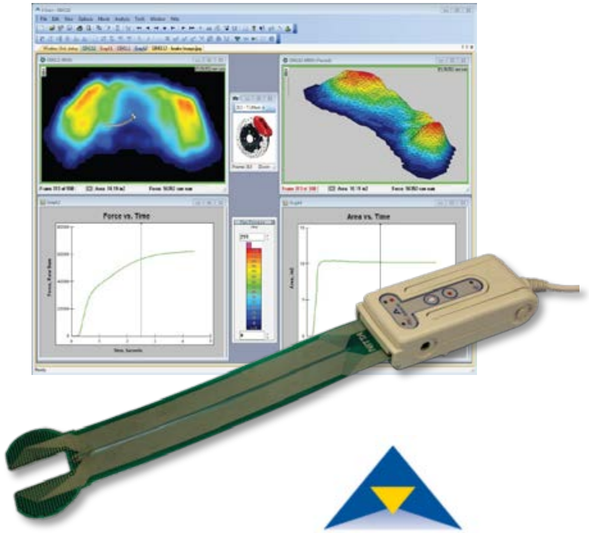
The ORL has a Bose Electroforce BioDynamic test machine. This uni-axial loading machine can apply a maximal load of 200 N.

Dynamic or static loading can be performed under incubator circumstances. Hence, tissue growth and biological specimens within a sterile environment can be tested, and the biological tissue can be subjected to in-vivo biomechanical loads.

Supporting techniques for Biomechanics

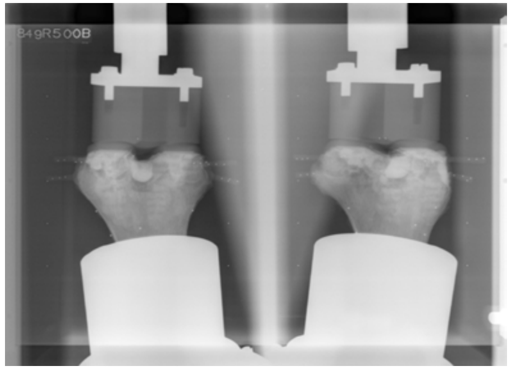
Tekscan Pressure mapping.

The ORL utilizes Tekscan pressure mapping to assess how joint loading is altered due to interventions such as cartilage repair, ACL reconstruction, implant positioning and other reconstructive techniques. We have ample experience in calibrating and registering the pressure maps in a reliable way.



Tekscan®

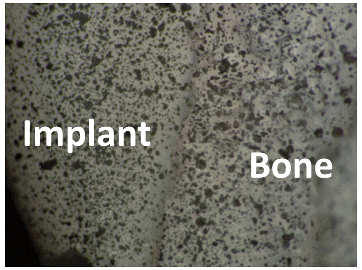
Radiostereometric Analysis



We are experts in the applications of radiostereometric analysis (RSA) to quantify the 3-D motion of one segment to the other. This is of high relevance if we want to determine the migration of an implant relative to bone upon dynamic loading, or if we want to determine how much soft tissues deforms due to loading or kinematic changes.
Depending on the experimental conditions the accuracy of this technique is around 50 microns.

Digital Image Correlation

Digital image correlation and tracking is an optical method that employs tracking and image registration techniques for accurate displacement and strain measurements. We utilize this technique to quantify micro-motions between implant and bones and to determine strains in soft tissues.



Micro-motion testing

Soft-tissue testing

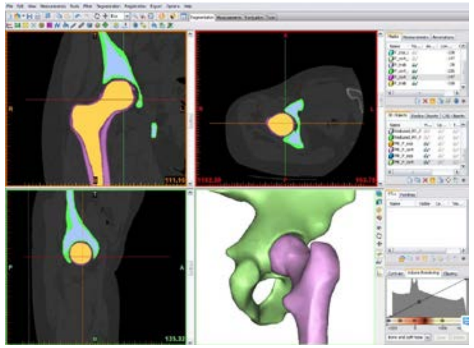
Fastrak motion tracking

To measure 3-D motions of segments the ORL has the capability of using a Fastrak motion tracking system. This system is based on electromagnetic principles which limits the experiments to non-metal investigations. This system can be easily used to quantify joint kinematics and how they change due to an interventions such as placing a prosthetic component or performing a surgical reconstruction. Errors are smaller than 1 mm in translation and 1 degree in rotations.

Supporting techniques for preparing Finite Element simulations and 3D cutting blocks

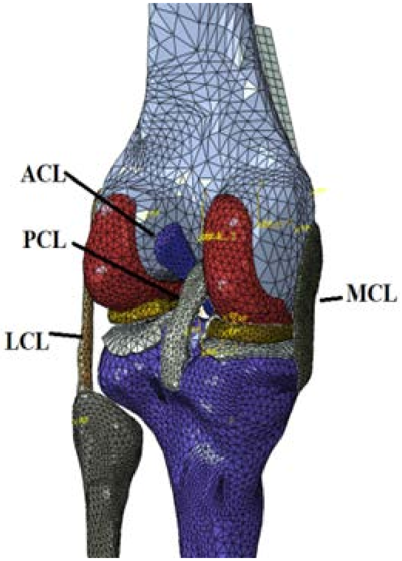
Image Segmentation

The ORL has commercial software licenses to segment MRI and CT images. In addition, extensive in-house software is developed to automate segmentation and to co-register 3-D segments. CT-densities are co-registered to allow for fast creation of density-based finite element models. Furthermore, we have tools to segment soft tissues such as muscles, ligaments, cartilage, and menisci.
The registration algorithms allow for fusion of various imaging modalities (e.g. CT and MRI) and for quantification of positional changes of the segments (e.g. kinematics of joints).



Finite element models

We have ample experience in finite element analysis of the musculoskeletal system, particularly of the hip and knee joint.
We are experts in non-linear and incremental analyses such as bone fracture, micro-motions of implants, interface failure, bone remodeling, failure and creep in materials.

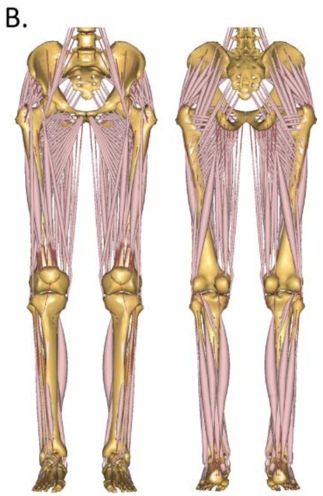


3D-printing

Together with the 3D-lab of Radboudumc we are developing patient specific surgical guides. We have over 7 years of experience in the maxillofacial area. Surgical guides in the orthopaedic field are applied to tumor surgery, ACL reconstruction, osteotomies, implant positioning.

Musculoskeletal models

Together with the University of Twente we have developed a strong capability to simulate muscle activity in healthy subjects and in patients. Models have been validated with in-vivo telemetric measurements. Specific applications are the analysis of implant design and positioning, the prediction of function after tumor surgery and simulations of patella-femoral surgery.

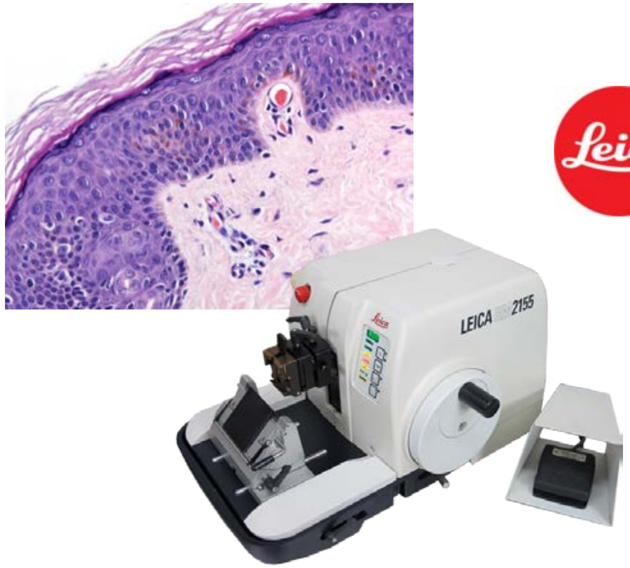


Supporting techniques for cutting and sawing hard materials

We have specific expertise in cutting and sawing hard materials like bone, ceramics and metal implants for histology purposes. For this we make use of specialized apparatus and materials.

Leica Rotationmicrotome

The Leica RM2155 is a reliable rotary microtome designed for fully motorized sectioning of both paraffin and resin-embedded specimens.



Leica Sawmicrotome

The Leica SP1600 saw microtome is specially designed for the cutting of extremely hard and brittle industrial materials embedded in methylmetacrylate with a maximum size of 35 mm in diameter.

The Leica SP1600 saw microtome works with different materials ranging from decalcified or undecalcified bone with implants embedded in methylmethacrylate; teeth; mineralogical samples to all kinds of industrial materials, such as steel, titanium or bioceramics.

Resin-embedding

MMA-embedding resin:
For mineralised tissues as well as soft tissue with an expanded study spectrum in light microscopy. The deplasticized sections are suitable for histological overview staining, enzyme chemistry and immunohistological studies, including in-situ hybridisation.

GMA-embedding resin:
A hydrophillic resin, used in medicine, botany, zoology and in the industry for embedding tissues for light microscope studies. The sections can be used for histological staining and enzyme detection.
It is not necessary and also not possible to elute the plastic out of the block and the section.

Fields of application:
- Hard-cutting technique for making thin layers.
  For example: spongy and compact bone tissue
- Division thin section
  For *example: tissues with and without implants*

Are you interested in using one of our techniques ??

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