UNIVERSITY OF COPENHAGEN
DEPARTMENT OF COMPUTER SCIENCE

Hip joint stress analysis considering anatomical variations

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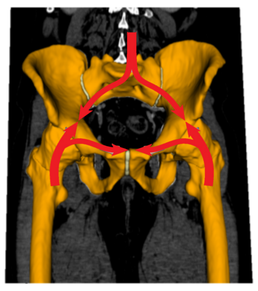
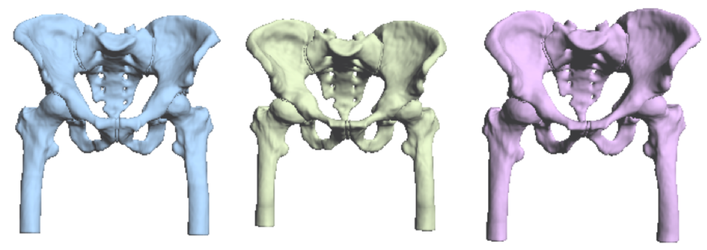
Motivation
We are developing a finite element analysis (FEA) framework to framework to perform population studies on the human musculoskeletal system on bone related clinical problems.





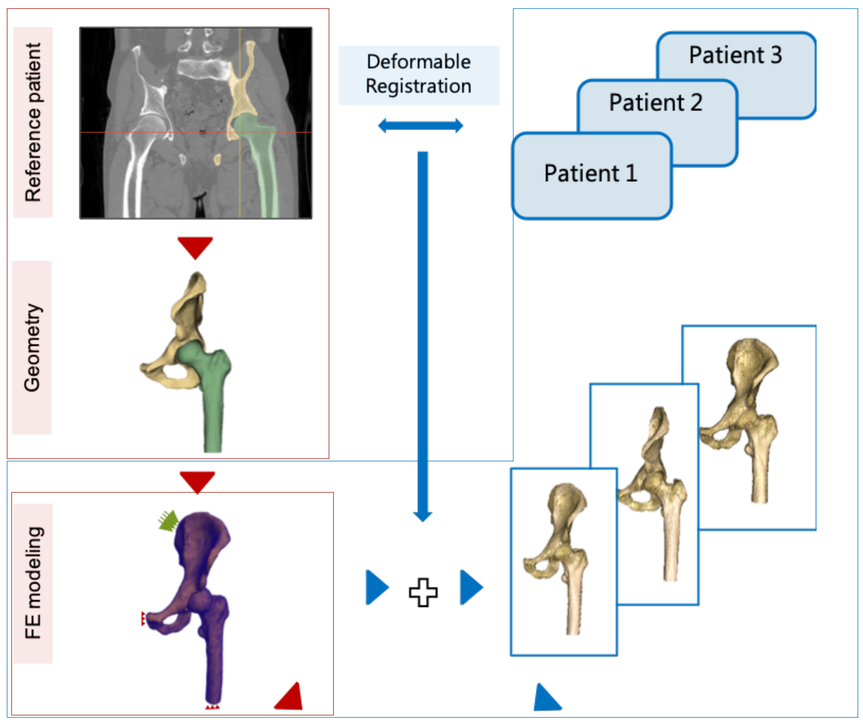
Finite element approach

In this study, we first develop a pelvic region FE model based on CT scans and measure the stress distribution in the acetabular surface in the stance posture. We then increase our study population to to investigate how anatomical variations correlate to stress values. To avoid repeating time-consuming FE model preparation steps, we use image registration techniques to deform the previous FE model to fit the new subjects.

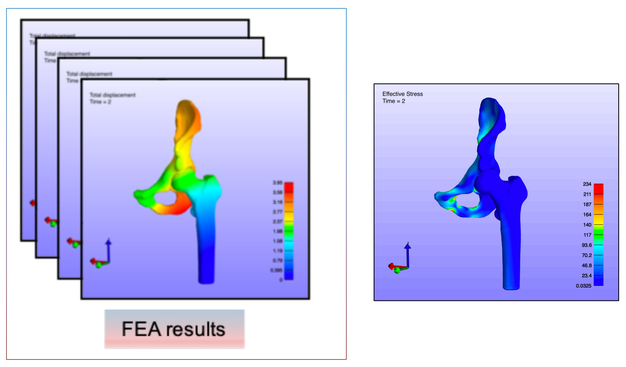
- CT scan of the pelvic and femur region
- Semi-automated segmentation

- We analyzed the bone under quasi-static loading to model stance position
- A compression force representing the body weight is applied to the pelvic

- The stress and displacement values are calculated in the articulating surfaces.

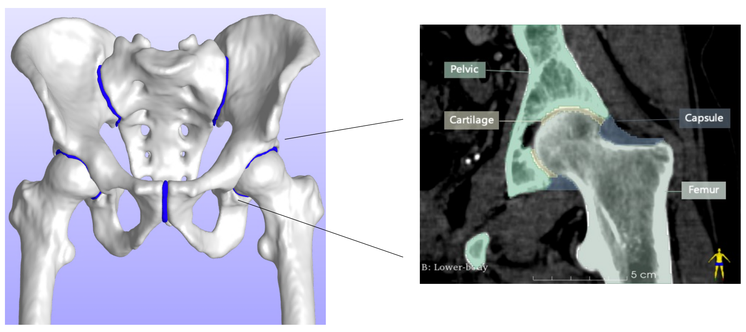


- Multi subject analysis is performed using deformable image registration.
- The new FE models are generated automatically with no need of image segmentation.

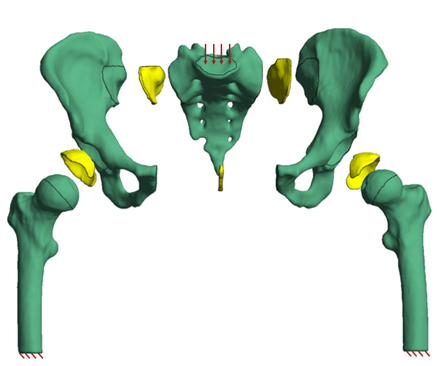


Cartilage reconstruction

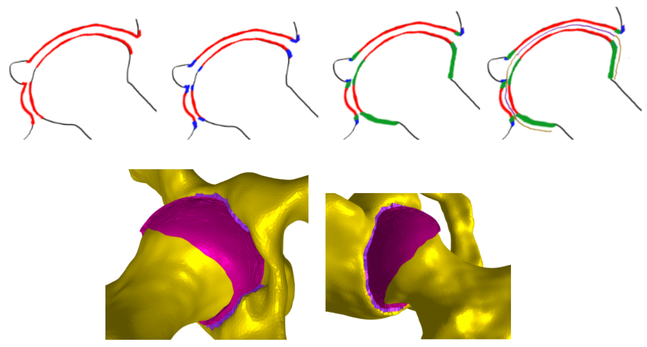
Generating computational meshes of cartilage tissue are difficult and close to artistic craftsmanship of a trained specialist. On the left a typical CT image is shown. Observe that it is nearly impossible to distinguish touching cartilage. On the right you can see an example of cartilage volume meshes generated with two different methods. The first method involves manual segmentation and the second shows our novel geometry method for auto-generation using only the geometry of the bones.



Pelvic gridle



Cartilages modelled manually as bone gap fillers



Auto-generated cartilages based on signed distance field method

Acknowledgements

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