Clinical applications of musculoskeletal modelling

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Musculoskeletal modelling to support clinical gait analysis:
theoretical, practical, and hands-on considerations

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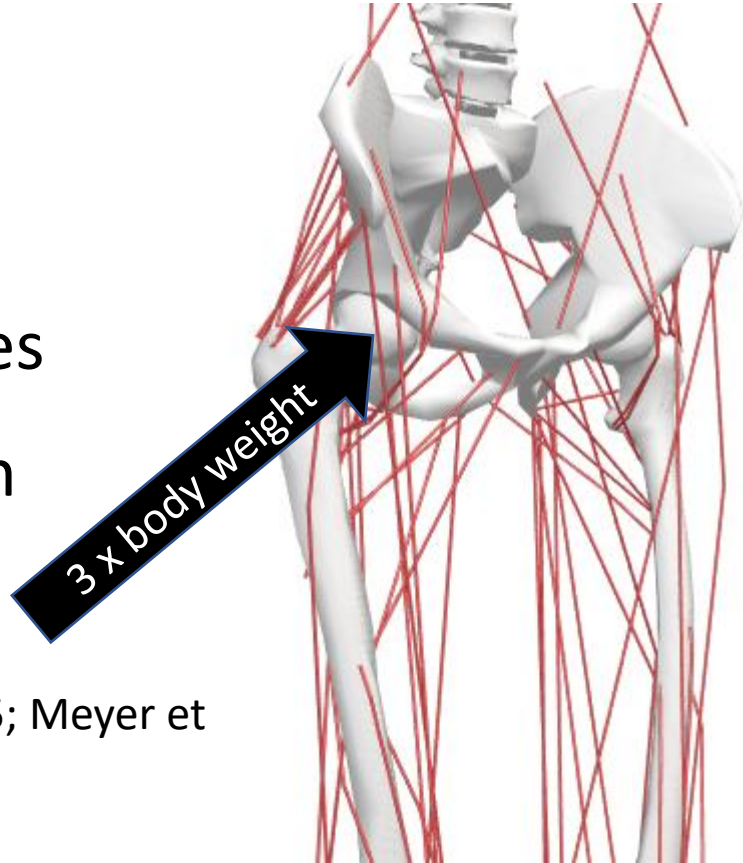
Clinical applications

- Biomarkers to increase our insights in diseases
- Improve evidence-based rehabilitation
- Planning of clinical interventions

Biomarkers to increase our insights in diseases

Previsous studies investigated

- if joint contact forces are altered after knee ligament reconstructions
- if cartilage defects alter compartment loading
- if osteoarthritis alters joint loading
- if surgeries alter muscle und/or joint contact forces
- if growth plate loading are altered in children with cerebral palsy



Saxby et al, 2016; Van Rossom et al, 2018; Meireles et al, 2017; Wesseling et al, 2015; Meyer et al, 2018; Kainz et al, 2019; Van Rossom et al 2020; Killen et al 2020; Kainz et al, 2021

Improve evidence-based rehabilitation

Previsous studies

- quantified knee joint loading during different rehabilitation exercises
- proposed a ranking of exercise to prevent femoral neck bone loss in females at risk of osteoporosis
- quantified muscle and joint contact forces during exercises with an elastic resistance band
- quantified the relative risk of impingement during different sexual positions after total hip arthroplasty
- used gait re-training based on real-time feedback

Killen et al 2020 ;Van Rossom et al, 2018; Pellikaan et al 2018; Bühler et al 2021; Charbonnier et al, 2014; Pizzolato et al 2017, 2020

Planning of clinical interventions

Implants

- In silico implant testing
- Implant size and alignment
- Risk factors based on the patient‘s gait kinematics

Design optimisation

- Insoles for diabetic foot care
- Assistive devices, e.g. prosthetic device
- Exosekeleton

Predicting of surgical outcomes

Killen et al 2020 ; Vanheule et al 2017; Innocenti et al 2016; Aerts et al, 2017; Rohani et al, 2017; Vantilt et al 2019; Pitto et al, 2019.

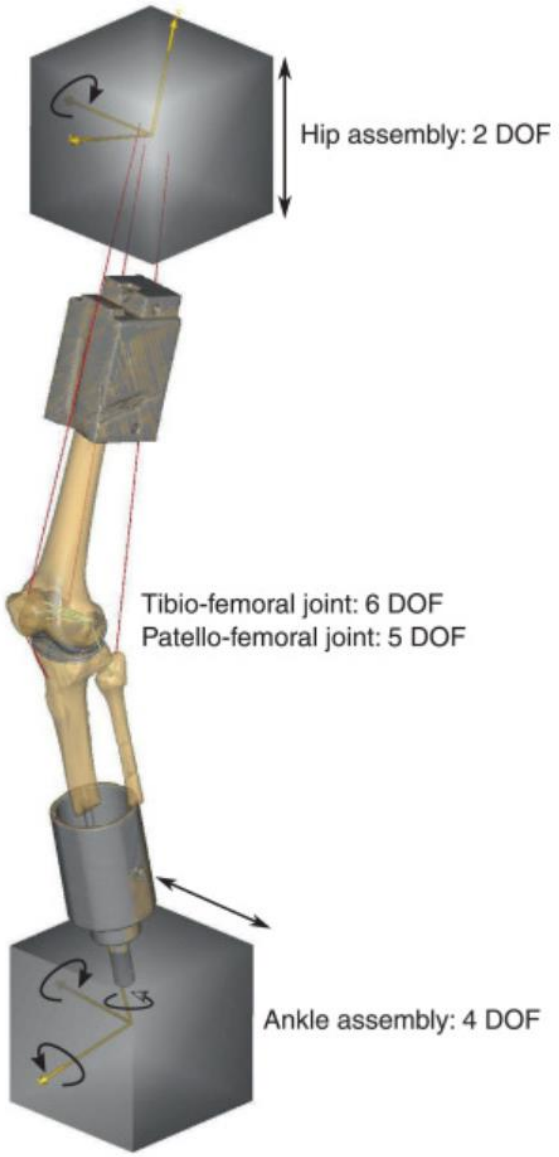


Figure from Vanheule et al 2017

Challenges and limitations

- Geometry → important but time-consuming and expensive
- Muscle properties → difficult to quantify and validate
- Motor control → challenging to account for and validate
- Surgeries
  - Bony surgeries → easy to implement
  - Soft tissue surgeries → difficult to implement
  - Neurosurgery → very difficult to implement

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