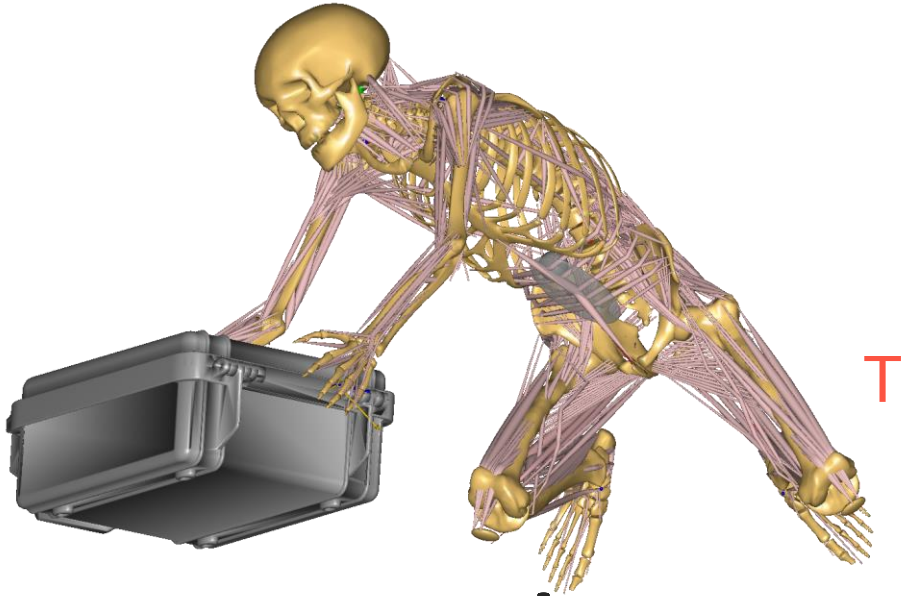


The webcast will start in a few minutes….

Loading an aircraft

VALIDATION OF THE LUMBAR SPINE MODEL AND ANALYSIS OF LUMBAR LOADS IN AIRPORT BAGGAGE HANDLERS

November 10th 2015

Outline

- Introduction by the Host
- Loading an aircraft
    - Validation of the lumbar spine model
    - Analysis of lumbar loads in airport baggage handlers
- Final words from the host
- Questions and answers

Henrik Koblauch, Ph.D.
(Presenter)

Ananth Gopalakrishnan
(Host)

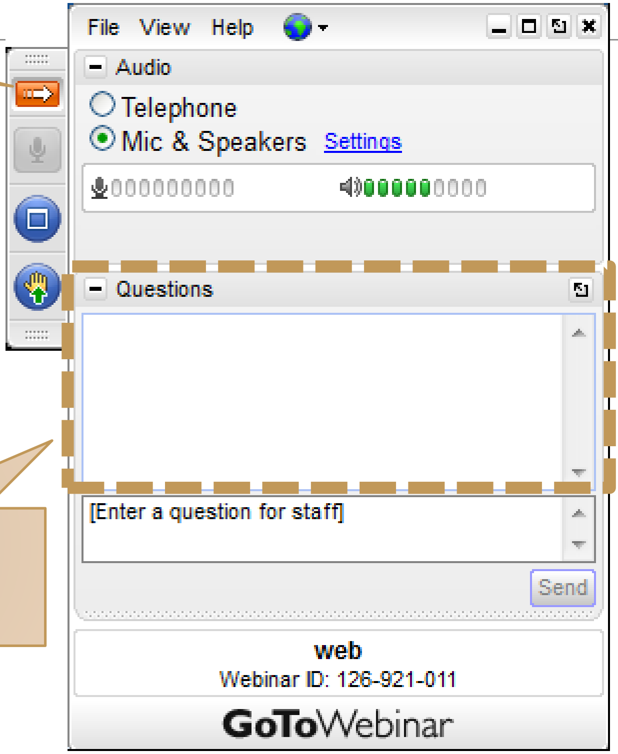
Control Panel

The Control Panel appears on the right side of your screen.

Submit questions and comments via the Questions panel.

Questions will be addressed at the end of the presentation. If your question is not addressed we will do so by email.

Expand/Collapse the Control Panel



○ Telephone
● Mic & Speakers

[Enter a question for staff]

web
Webinar ID: 126-921-011

Ask a question during the presentation

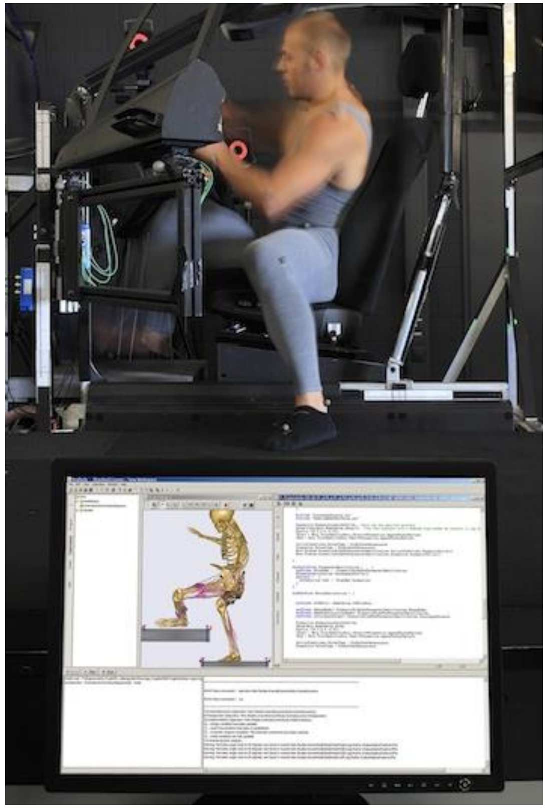
AnyBody Modeling System

Musculoskeletal analysis

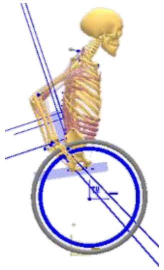
AnyBody Managed Model Repository

Wide range of simulation options

- Motion capture
- Ground reaction force prediction
- Imaging → Patient-specific anatomy
- Man-machine simulations



Rasmussen et. al. (2011), ORS Annual Meeting

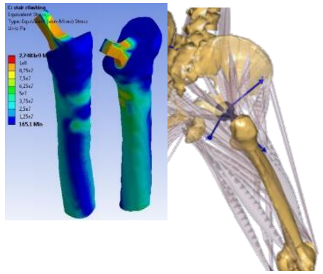


Product Design Optimization

Movement Analysis

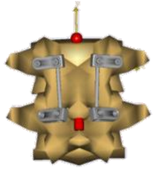
ANYBODY Modeling System

Ergonomic Analysis

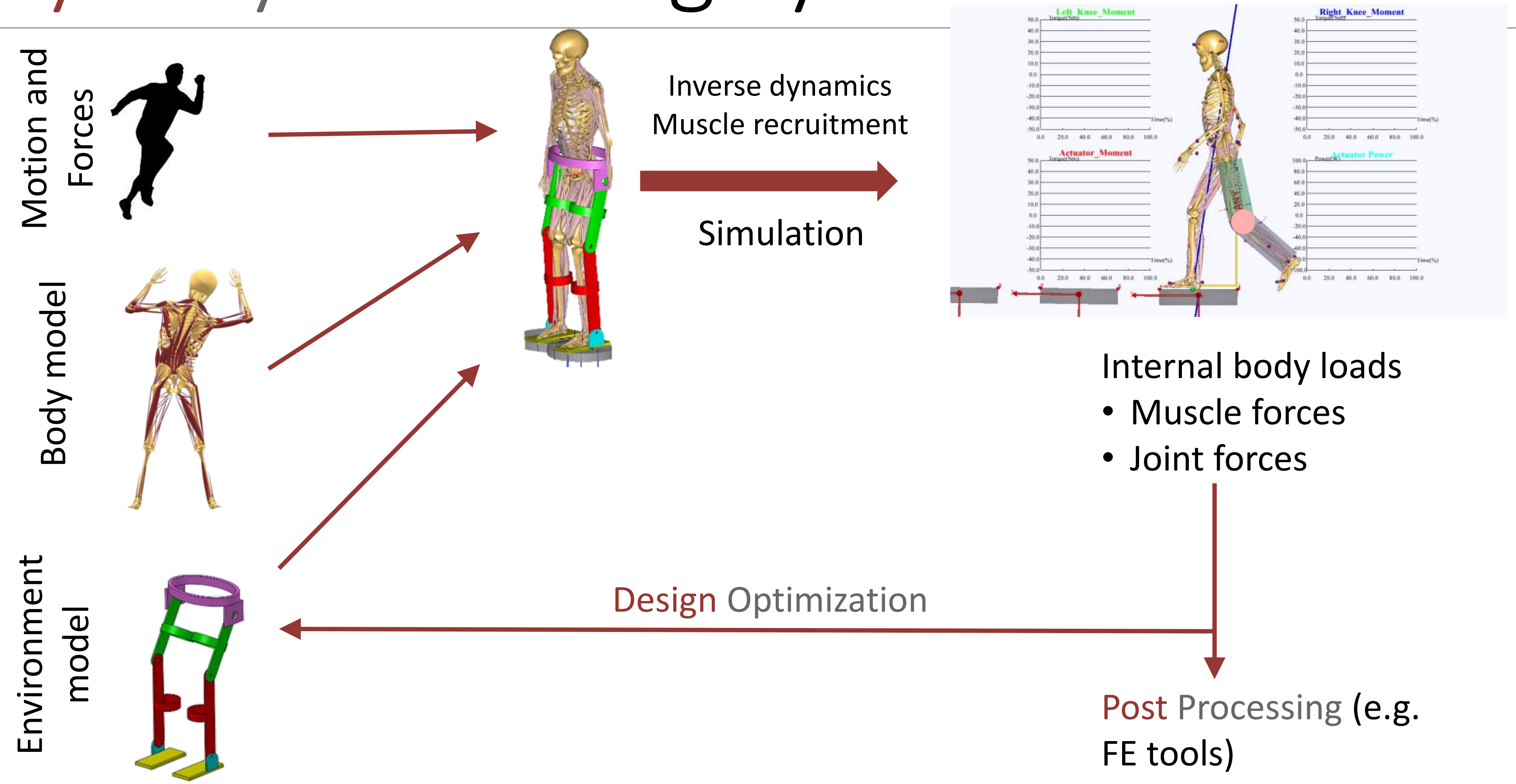


Load Cases for Finite Element Analysis

Surgical Planning and Outcome Evaluation



AnyBody Modelling System



Motion and Forces

Body model

Environment model

Inverse dynamics
Muscle recruitment

Simulation

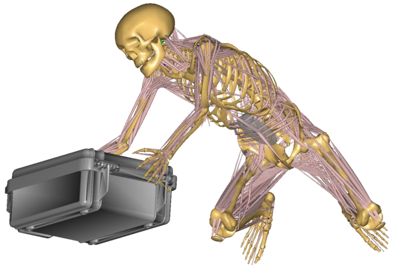
Internal body loads
- Muscle forces
- Joint forces

Design Optimization

Post Processing (e.g. FE tools)

Henrik Koblauch, Ph.D.
Assistant Professor at the
School of Physiotherapy UCC,

Loading an aircraft



VALIDATION OF THE LUMBAR SPINE MODEL AND ANALYSIS OF LUMBAR LOADS IN AIRPORT BAGGAGE HANDLERS

November 10th 2015

Low back load in airport baggage handlers

Henrik Koblauch, Ph.D.

University College Capital, School of Physiotheray
Department of Neuroscience and Pharmacology, University of Copenhagen

AnyBody Webinar
November 10th 2015

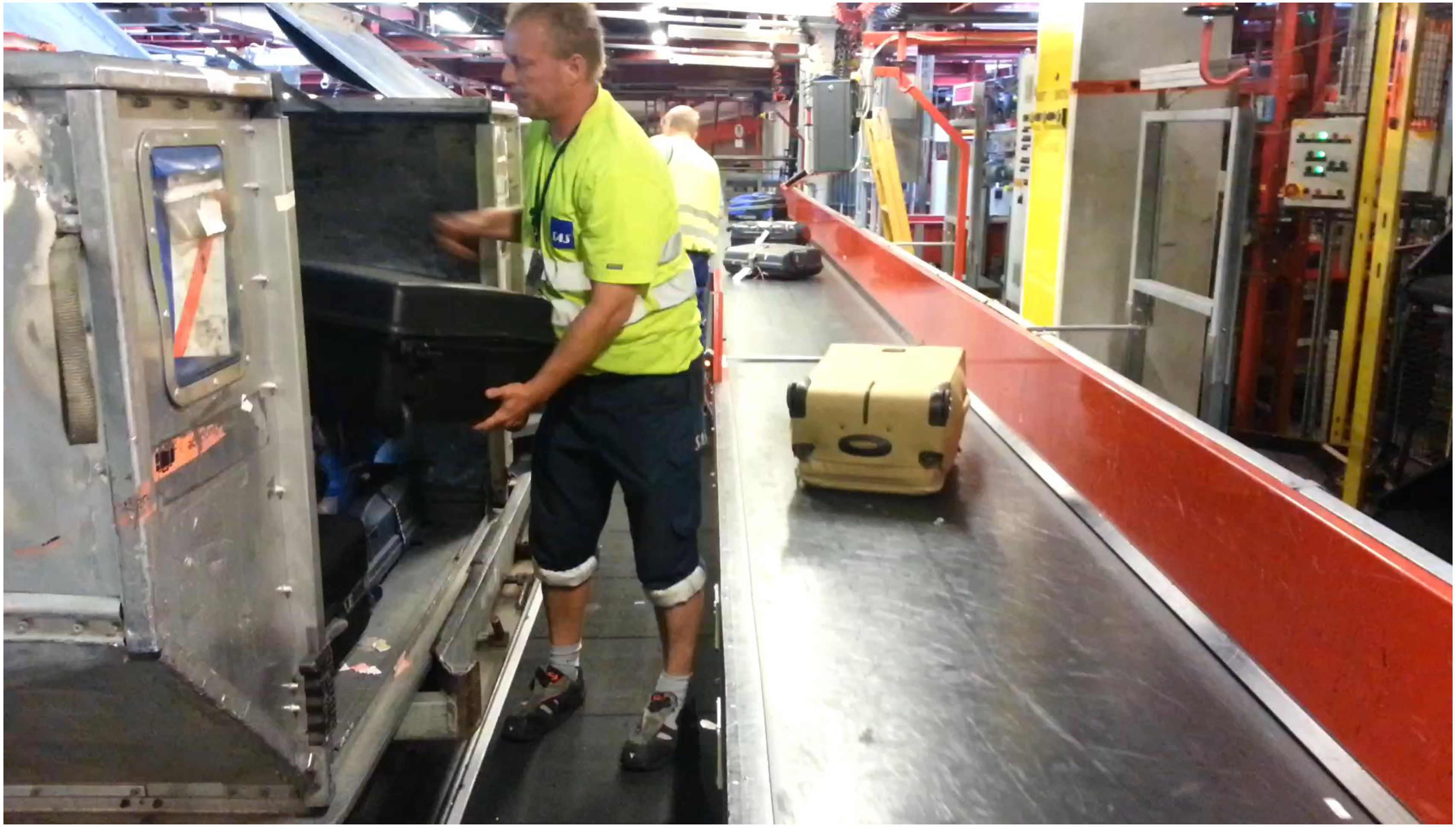
Introduction

Part of the Copenhagen Airport Cohort

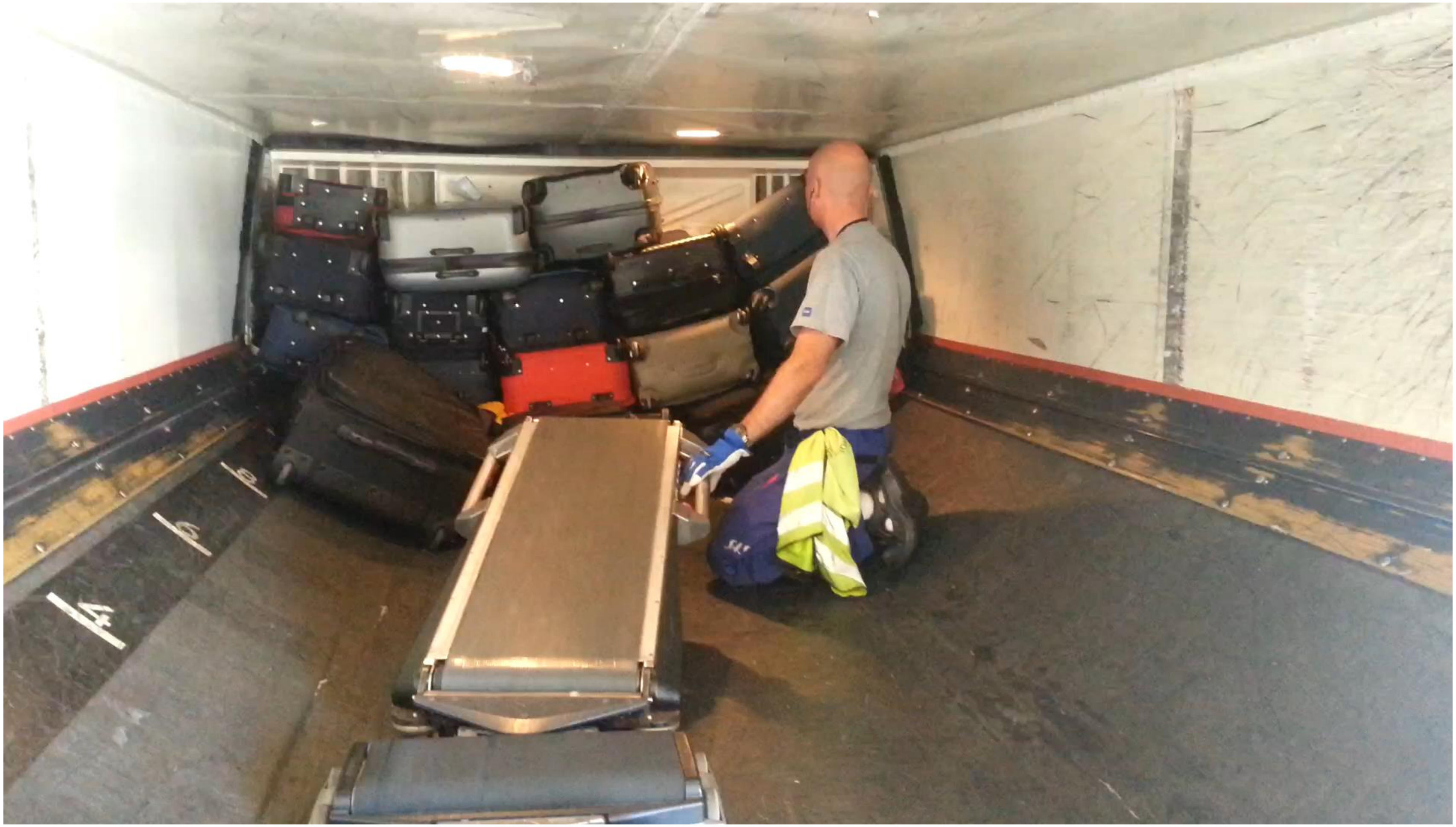
- Aim to describe and analyze causes of musculoskeletal injuries in airport baggage handlers in Copenhagen Airport

- Cohort of 3396 present and previous baggage handlers

Real life baggage handlers



Real life baggage handlers



Real life baggage handlers

Background

- High prevalence of musculoskeletal complaints in baggage handlers. (Undeutsch, 1982; Stålhammer, 1986; Bern, 2013)

- The job as a baggage handler is characterized by:
    - Heavy lifting and non neutral working positions are common.
    - Asymmetrical lifting

(Brauer, 2013; Stålhammer, 1986; Riley, 2009; Tapley, 2005)

Background

- Heavy lifting and lifting in awkward positions is known to increase the load on the spine. (Stålhammer, 1986; Gallagher, 2001)

- The increased spinal load is a known riskfactor for back pain. (Coenen et al, 2013 & 2014; Waters et al, 2014)

Purposes

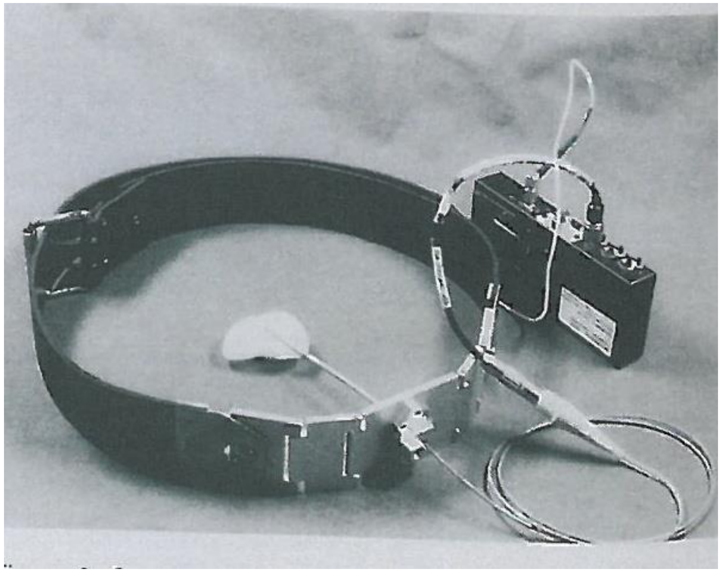
- To develop a generically useful tool to examine specific lumbar compression in a valid manner.
- To investigate the spinal loading in common work tasks for baggage handlers.

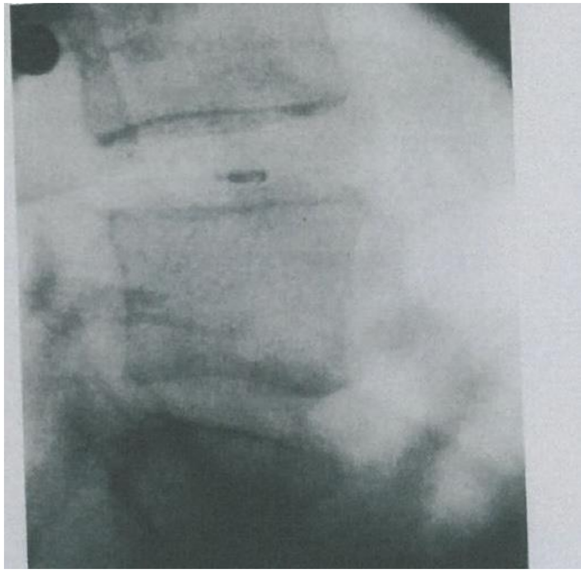
Methods

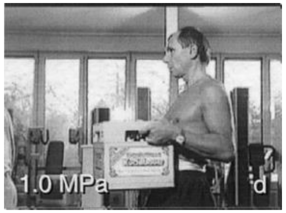
- Wilke et al. published estimates of intra-discal pressures during various dayly activities

(Wilke et al 1999 & 2001)

- A pressure gauge was inserted in the L4/L5 disc and data was recorded different activities



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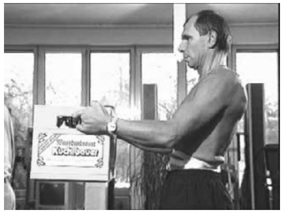

Methods

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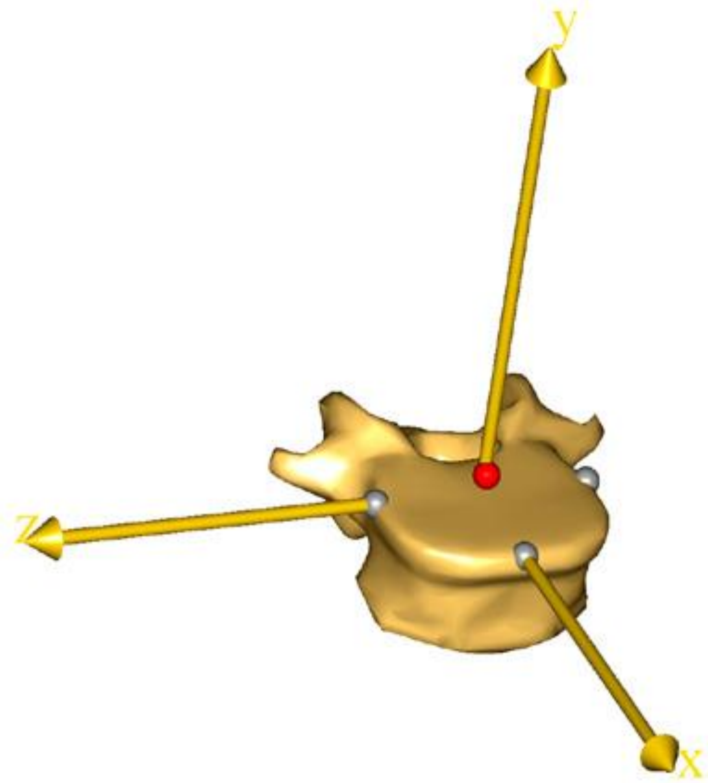
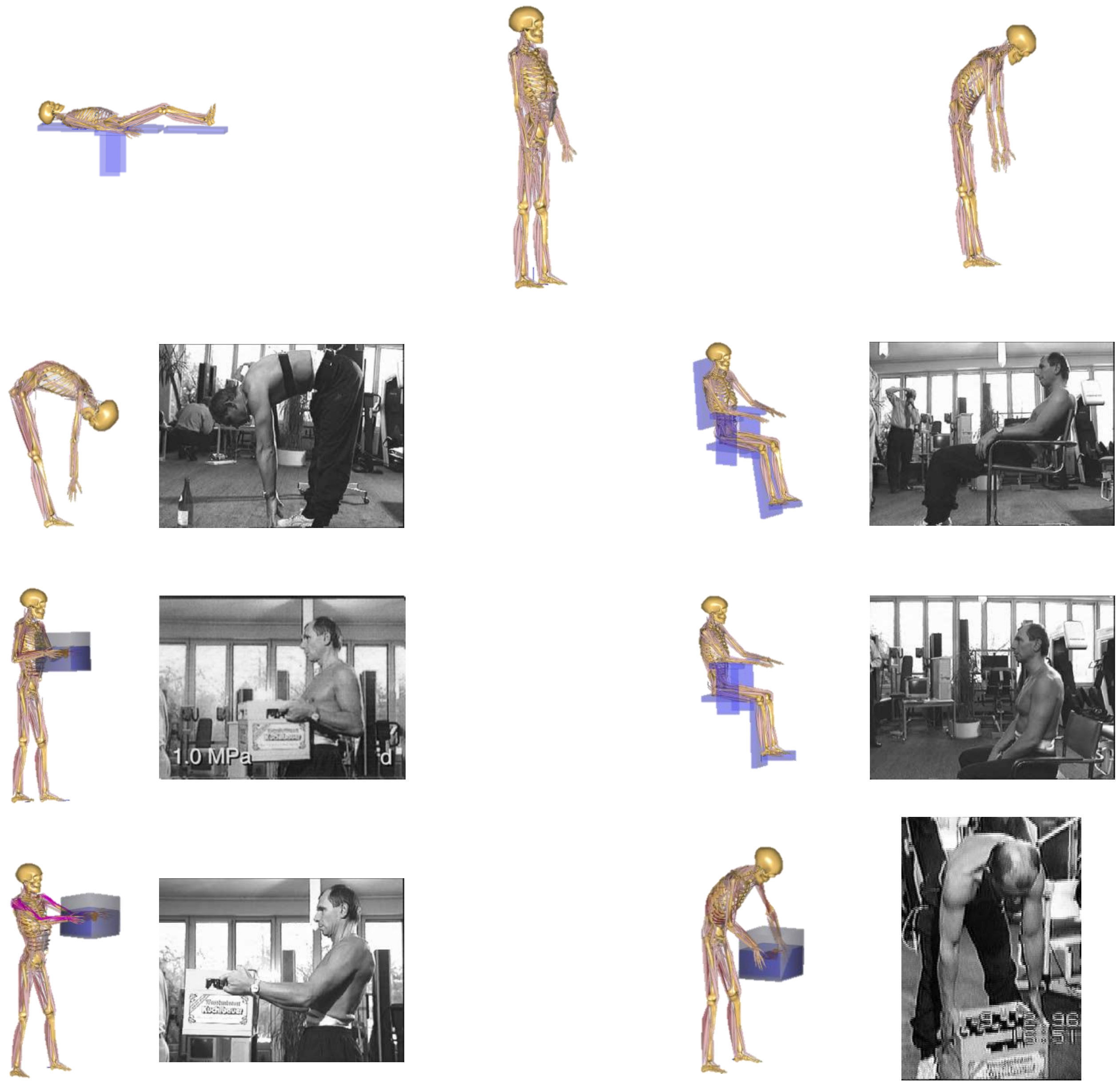
  - 3rd or
  - Min/m




1.0 MPa
d

Methods

- Intra-discal pressure estimates were converted to force using:

$$F = PAC_{corr}$$

- Where P is the estimated pressure, A is the area of the disc (1800 mm^2), and C_{corr} is a correction constant of 0.77

(Dreischarf et al, 2013)

Results

In vivo measurements
3rd order polynomial
Min/max criterion

Results

Position/Estimate	Wilke in vivo (N)	3rd order polynomial (N)	Difference (N / %)	Min/Max-criterion (N)	Difference (N / %)
Lying supine	139	110	-29 / -21	138	-1 / 0
Sitting relaxed	457	279	-178 / -39	290	-167 / -37
Standing	693	522	-171/ -25	548	-145 / -21
Sitting straight	610	417	-193/ -32	424	-186 / -30
Standing flexed (60°)	1525	1520	-5 / 0	1730	205 / 13
Lift close to body	1525	1302	-223 / -15	1553	28 / 2
Max flexed	2218	1661	-558 / -25	2375	157 / 7
Lift stretched arms	2495	2208	-287 / -11	2581	86 / 3
Lift flexed back (60°)	3188	3173	-15 / -1	3350	162 / 5

Discussion

- High agreement between intra-discal pressure and modeled compression force with min/max muscle recruitment.
- Good trend agreement regardless of muscle recruitment criterion. (r = 0.995 resp. 0.993)
- Agreement improves when forces increase

Discussion – strength & limitations

- Intra-discal pressure during dynamic movements – model calculated load in one timepoint.
- The positions of the model were not exactly similar to the in vivo estimates.
- Segment properties of the model were based on antropometric fractions rather that data from the subject.
- Comparison with in vivo measurements.

Conclusion

- Model shows high agreement with in vivo intra-discal pressure
- The model responds adequately to changes in positions
- Assumptions in the model can question the validity

AIM

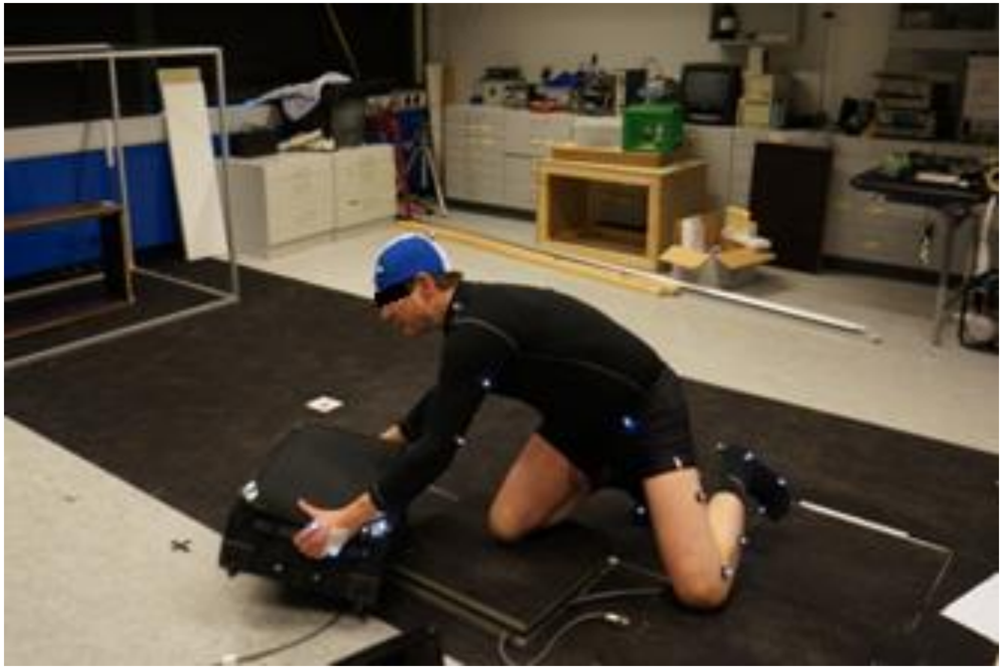
- We wanted to investigate the spinal loading in common work tasks for baggage handlers under dynamic consitions.

Material

- One professional baggage handler (male, 48 years, 1.81 m., 87 kg, 17 years seniority.)
- Stooped and kneeling baggage handling
- 20 kg, 15 kg and 10 kg suitcases were recorded

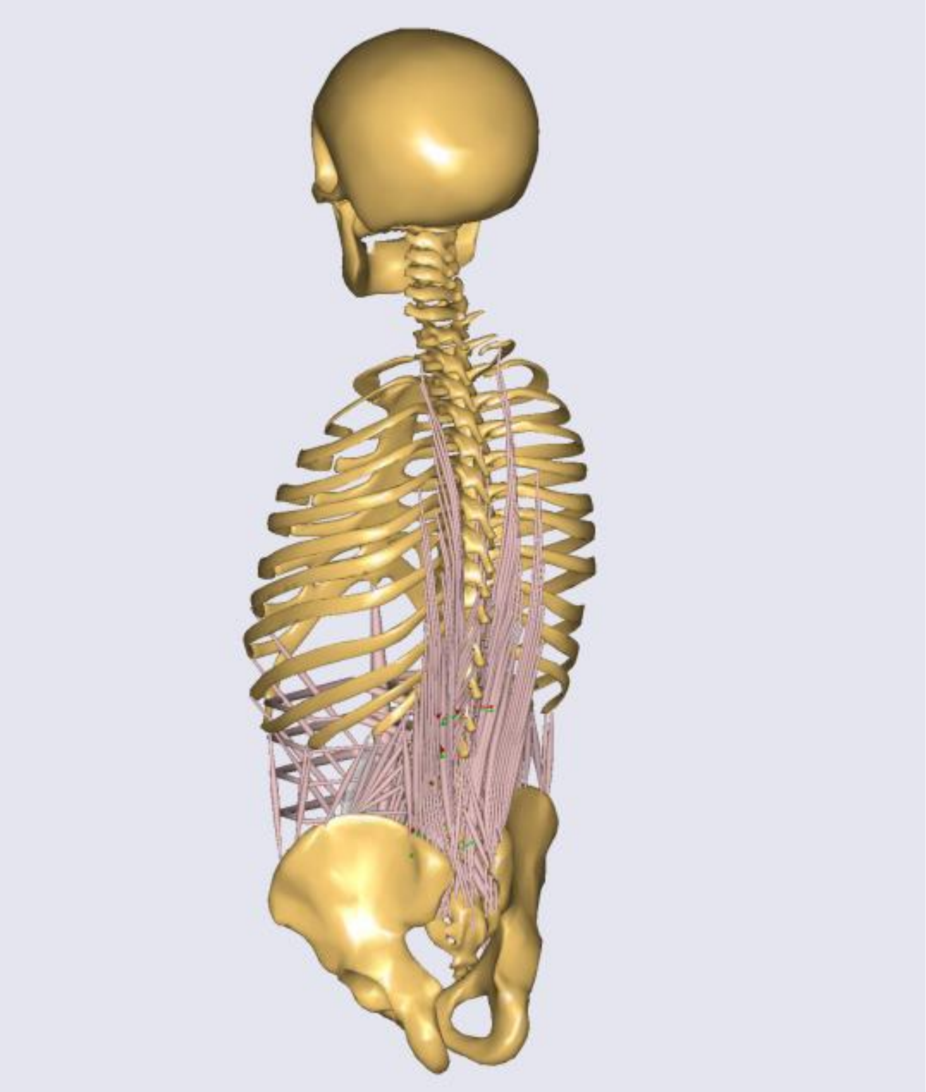
Methods

- A custom built motion capture system
- Eight synchronized high-speed HD cameras, sampling at 75 Hz
- Two (AMTI OR6-7) force platforms in the stooped task
- Four force platforms in the kneeling task
- Full body marker setup consisting of 38 markers + three suitcase markers



Musculoskeletal models

- Inverse dynamics based models in AnyBody Modeling System v. 5.3
- Based on the *GaitFullBody* model in the AnyBody Managed Model Repository (AMMR) v. 1.5.
- Kinematic data was used to drive the model.
- Spine model was included



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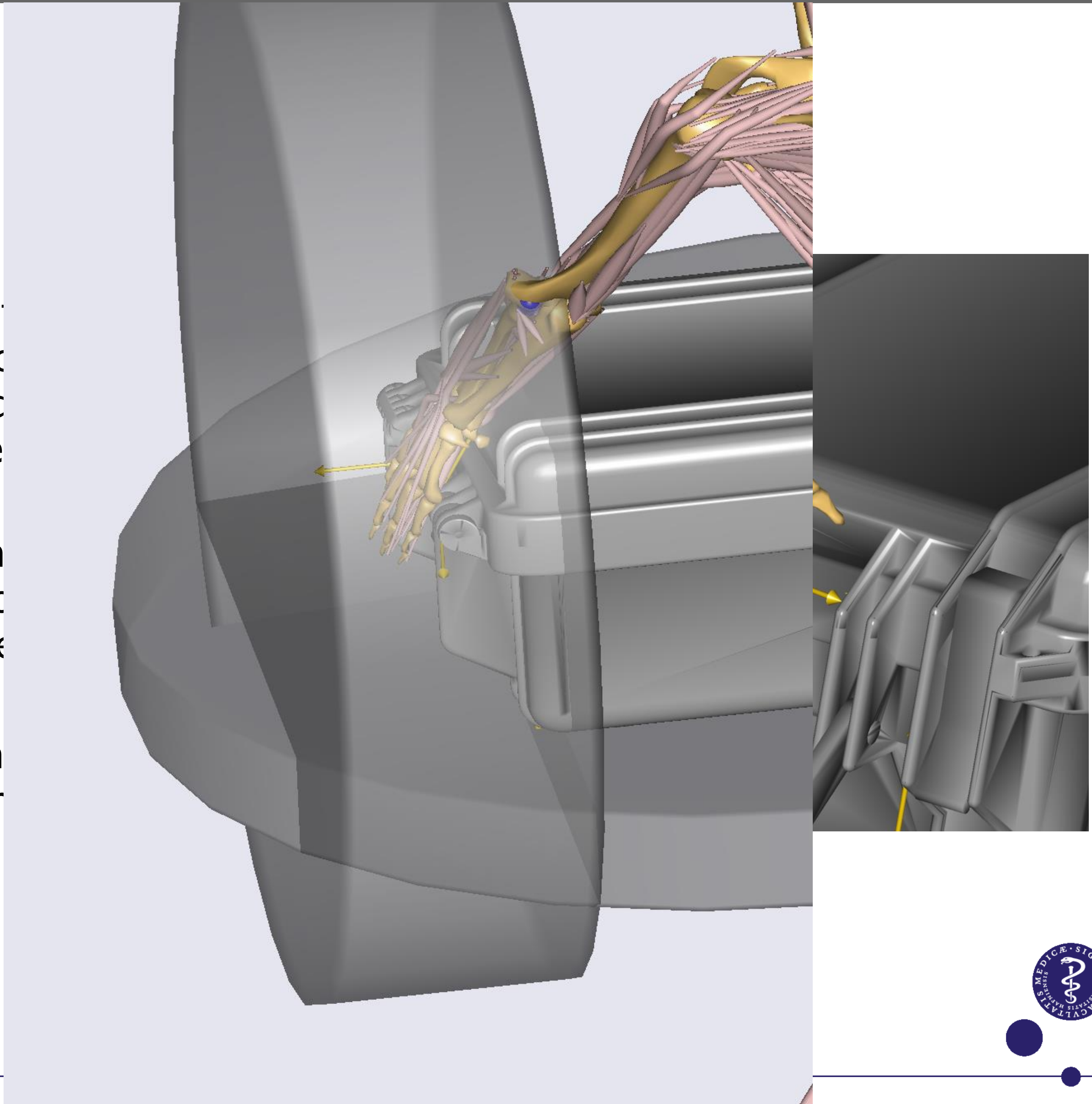
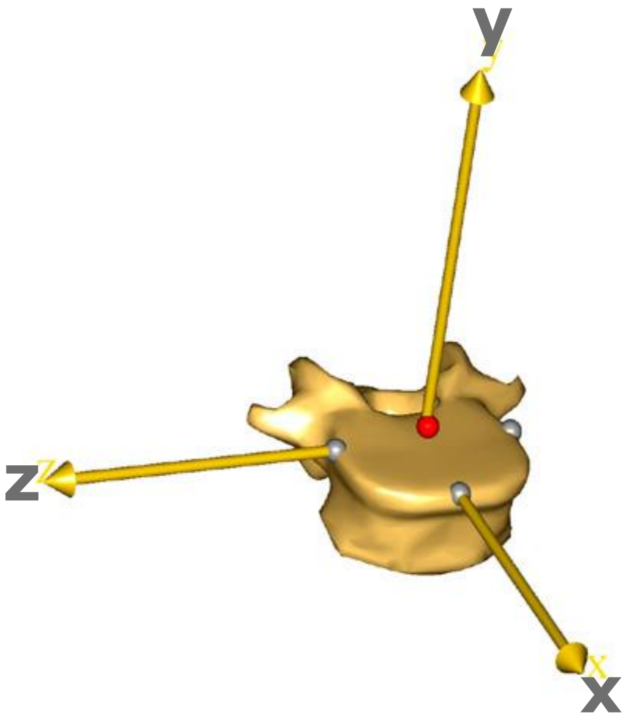
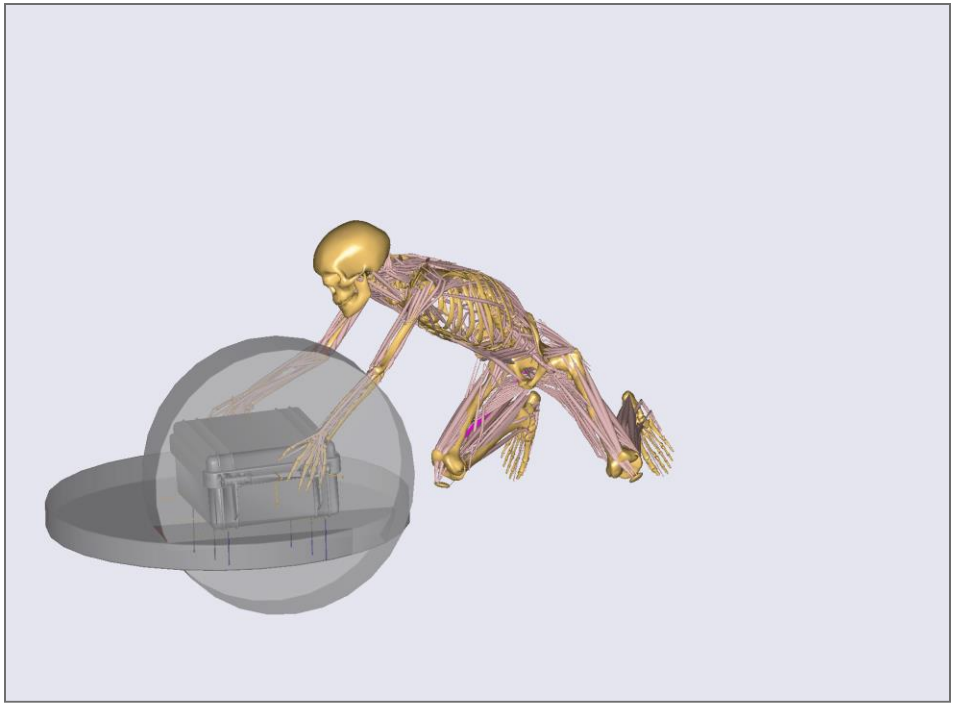


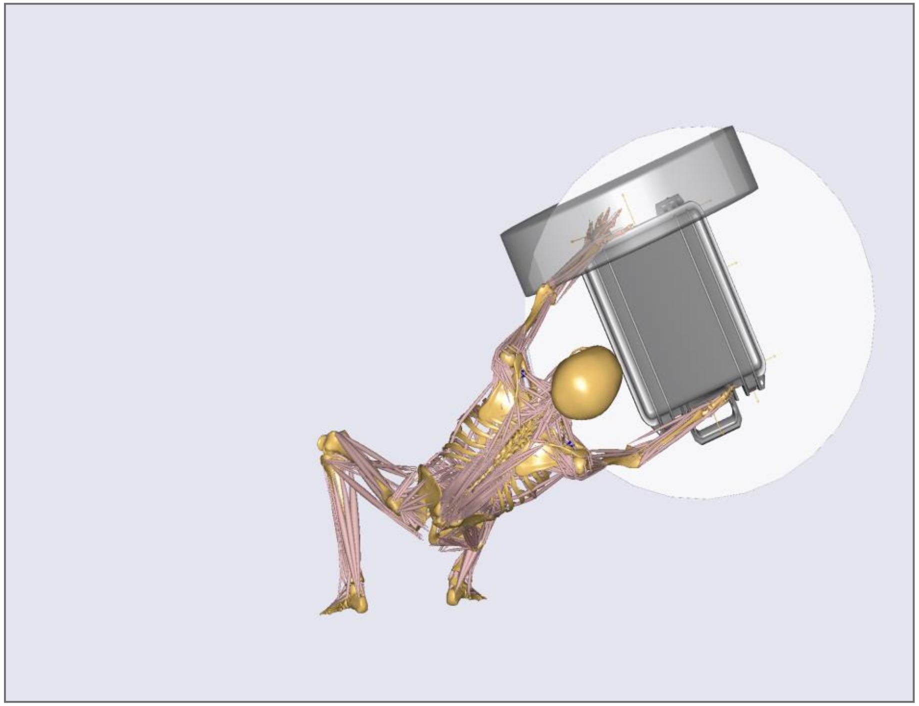
Data output

- Compression force
- Shear force
- Rotator moment

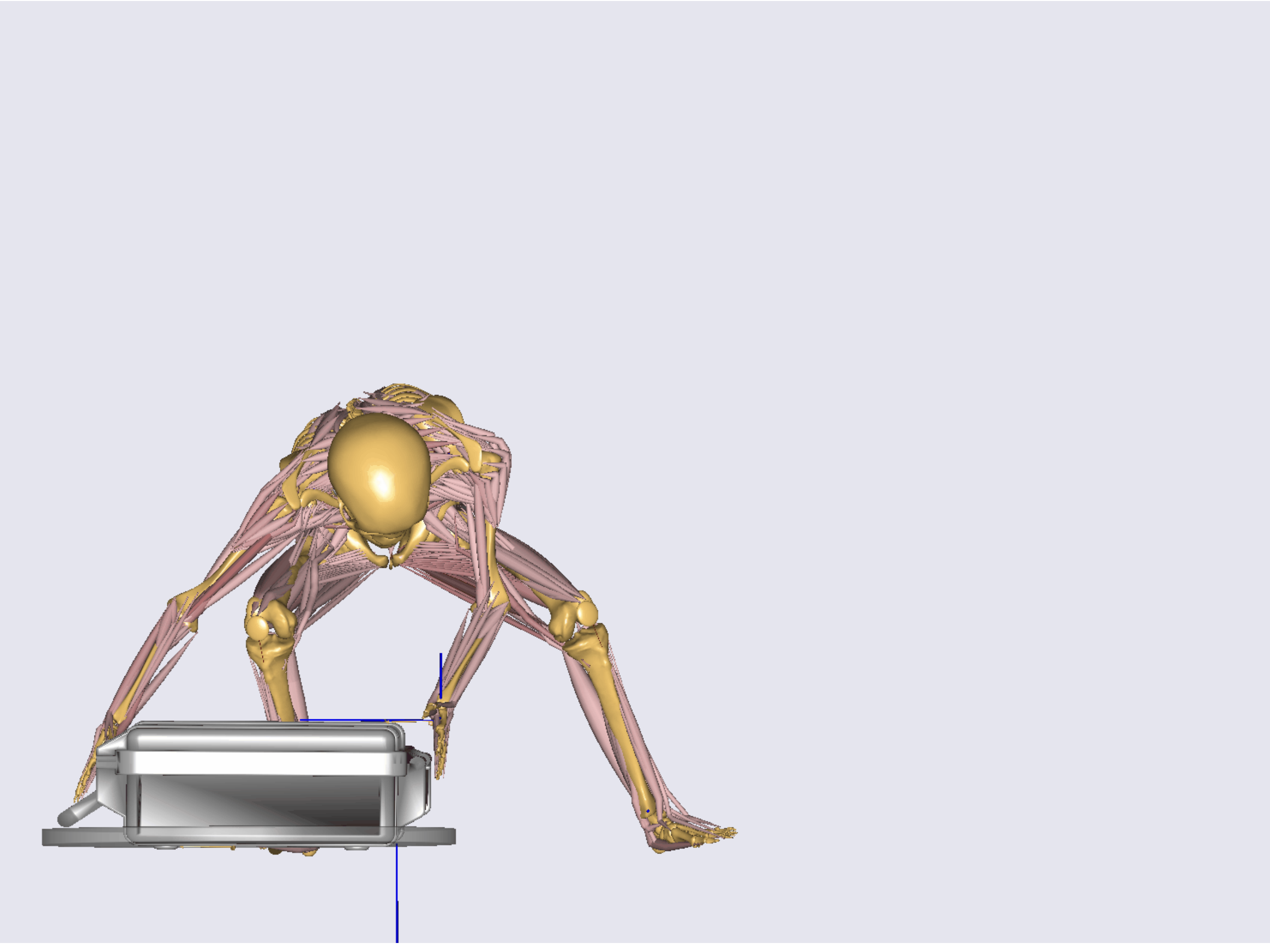


Results





Results



Results

Task	Weight (Kg)	Compression (N) (peak/median/IQR)	Shear (N) (peak/median /IQR)	Rotator moment (Nm) (peak/median/ IQR)
Kneeling	20	6561/3862/1860	200/123/66	69/9/79
Stooped	20	11542/7285/3712	551/337/177	165/94/60
Kneeling	15	7591/3376/1748	201/41/72	66/-2/75
Stooped	15	13410/4279/1886	578/127/84	152/82/74
Kneeling	10	6938/3012/1223	203/126/171	47/-22/66
Stooped	10	16636/7677/1215	345/106/148	173/81/31

Discussion

- Highest compression force in the stooped 10 kg task.
- The compression force exceeded the recommendations suggested by NIOSH (3400 N) in all tasks.
- Above to the average maximum compression tolerance cadaver studies (6180 N). (Jäger et al, 2001)
- Small shear forces. 1000 N for single cycles (<100) and 700 N for continuos work (Gallagher & Marras, 2012)

Discussion - strengths & limitations

- One subject and one trial
- Model allows analysis of 3D asymmetrical lifting
- Generically useful model to investigate lifting
- High level of detail

Perspectives

- The models from the present study can be used on any lifting situation
- Optimization of lifting tasks
- Data can be used to prioritize job rotations
- The use of data in epidemiologic study

Acknowledgement

Thank you

- Erik Simonsen, Mark de Zee, Michael Skipper Andersen
- Danish Work Environment Research Fund
- Family & friends
- AnyBody Technology for giving me the opportunity to present my work.

Thank you for your attention

Webcasts

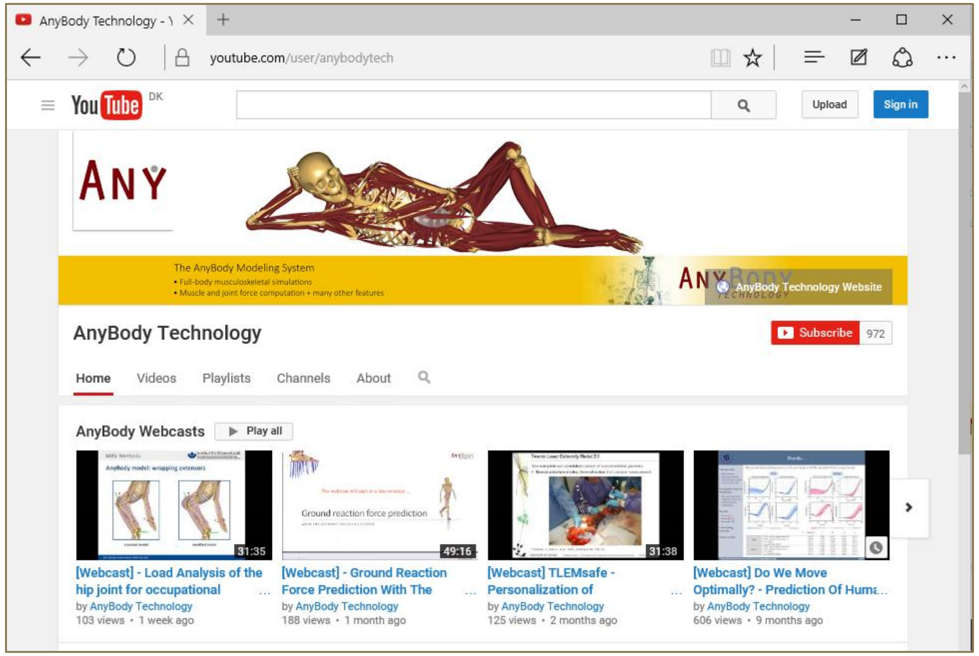
- No webcasts planned for December.
- Next webcast will be beginning of February
- Check our YouTube channel for previous webcast
  - Search channels for ‘AnyBody Technology’

www.anybodytech.com

- Events, dates, publication list, ...

www.anyscript.org

- Wiki, Forum



The AnyBody Modeling System
- Full-body musculoskeletal simulations
- Muscle and joint force computation + many other features

AnyBody Technology

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