

#### ROTARY SPINAL DYNAMICS IN GAIT – REFERENCE DATA AND FUNCTIONAL DESCRIPTIONS BASED ON SURFACE TOPOGRAPY

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\* The data analysis is part of the dissertation of Janine Huthwelker

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- no conflicts of interest -



#### MotionLab DIERS Formetric III 4D™ analyzing system



#### Software adjustments and data management

- Implementation of the export tool
- Course of rotation across three gait cycles of selected vertebral bodies
- Implementation of foot pressure data as variables in the raw data of the spinal model





#### Transformation in a Standardized Gait Cycle

- Linear transformation of the number of observations onto a scale from 0-100
- Averaging of data from three gait cycles
- Interpolating splines are applied to smooth curve progressions





#### Framework Project

 "The rasterstereographic investigation of intersegmental spinal movement pattern in healthy participants according to phases of gait at different walking speeds - a cross-sectional study"

Participants:

•201 structurally and functionally healthy participants•aged 18 to 70 years



#### Digression: The functional model of spinal dynamics

#### T7 stays orthogonal to the direction of movement and is "dynamically stabilized"

(Gregersen & Lucas, 1967; Suppé & Bongartz, 2013)







Gregersen & Lucas, 1967



(a)

ТЗ

13

#### Transformation in a Standardized Gait Cycle

- T7 stays orthogonal to the direction of movment and is "dynamically stabilized" (Gregersen & Lucas, 1967; Suppé & Bongartz, 2013)
- This segment (T8) shows the least rotatory motion compared to above and beneath (Needham et al., 2016)

**T**8

12 0.5 Difference between S1 & S2 (\*) TOALE. 3.15 18 PS SWING 12 & S2 () ICALR SWING 10 10 0.6 Axial rotation (°) 0.4 C S 0.2 S 0.4 6 0.2 -0.2 -0.4 0.6 -0.8 Differe -1 10 20 3.5 45 50 03 80 90 100 % Gait cycle % Gait cycle Session 1 ---- Session 2 • Difference (S1 versus S2) -Session 1



**T**3



L3

Existence of a "Point of Intersection" can be postulated at ~ T7







Maxima pelvis and lumbar spine occur sequentially with similar amplitudes





 Maxima of thoracic spine occur nearly simultaneously but with very different amplitudes





#### Most rotation at T7





#### Mean courses in SGC with 5% an 95% percentiles





#### Individual courses of spinal rotary motion during gait at 5 km/h within SGC





#### Individual courses of spinal rotary motion during gait at 5 km/h within SGC



Scatter plots of maxima (left, blue) and minima (right, red) within SGC

 high pelvic and lumbar individuality









#### Point of Intersection: not static but dynamic!





#### Limitations

- Surface topography is sufficiently investigated for static measures and therefore was found to be valid and reliable (Frerich et al., 2012; Mohokum et al., 2015; Tabard-Fougere et al., 2017)
- For dynamic measures no formal validation beyond face validity has been possible yet.
- Influence of possible soft tissue artifacts (skin displacement, muscle activity, movement of the scapula) has to be taken into account, especially during high walking speeds.



#### Summary

- A differentiated analysis of spinal rotary motion (trunk surface) while walking is possible by surface topography.
- most rotation at T7
- Maxima of pelvis and lumbar spine occur sequentially with similar amplitudes
- Maxima of thoracic spine occur nearly simultaneously but with very different amplitudes
- high pelvic and lumbar individuality
- dynamic point of intersection



# Thank you for your interest

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