

How much motion do we need to be able to walk: a full body analysis of asymptomatic adults

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Background and Aim

- Postural alignment is altered with age due to intervertebral disc and joint degeneration, consequently affecting quality of life (QoL) and activities of daily living, such as gait.
- Postural alignment parameters of the spine, pelvis, hips and lower limbs, measured on static standing radiographs, have been widely studied in asymptomatic subjects as well as in various patient populations, among which adult spinal deformity and adolescent idiopathic scoliosis.
- However, while most of these parameters are positional and could vary during gait, there are currently no studies investigating whether they are modified during walking.

To evaluate a range of postural, pelvic and acetabular positional parameters for asymptomatic adult subjects during walking

Population

- Asymptomatic adults
 - N=85
 - Age: 29 ± 5 years (18-60)
 - 37F:48M
 - No prior history of:
 - Back pain
 - Orthopedic surgery
 - Scoliosis (if Cobb $>10^\circ$)
 - Scheuermann's kyphosis
 - Leg length discrepancy

3D Gait Analysis

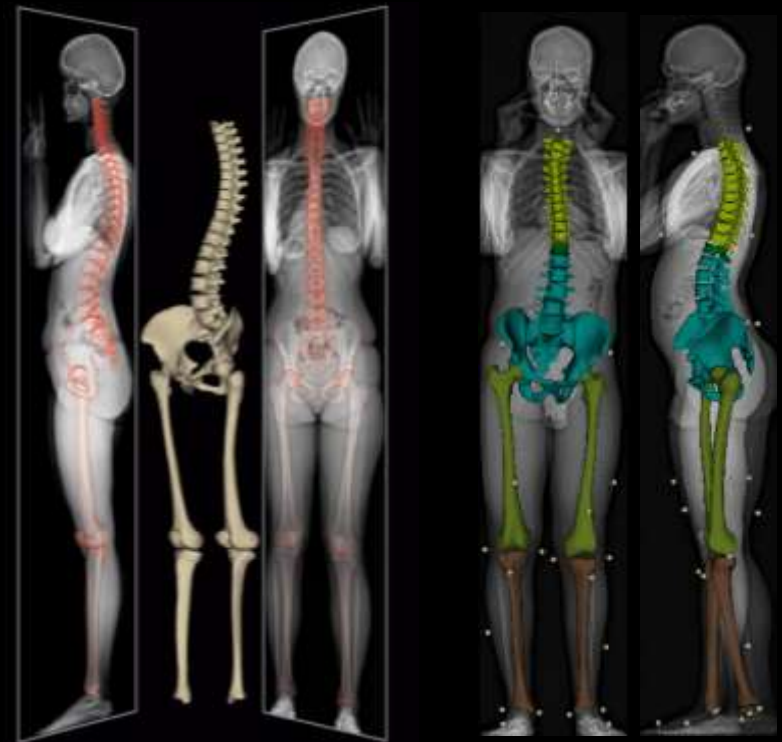
- 7 cameras - Vicon®
- Davis protocol
 - Additional markers:
 - femur, tibia & ankle
 - Several gait trials at self selected speed



Biplanar X-rays: EOS®

3D Reconstructions of :

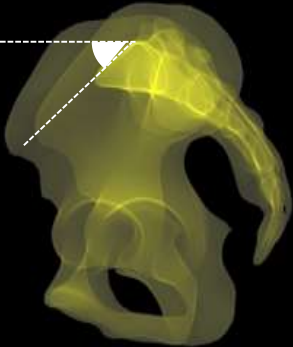
- Spine, Pelvis & lower limbs
- Reflective markers



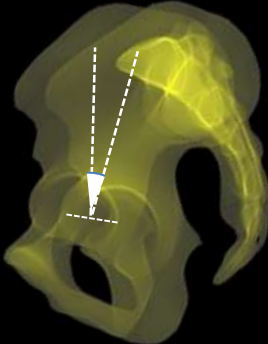
3D Pelvic parameters

Lazennec et al. 2004
Murray et al. 1993
Stem et al. 2006
Humbert et al. 2008

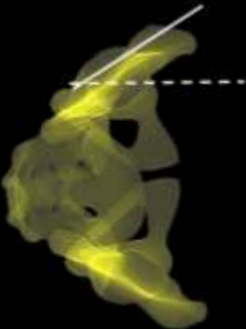
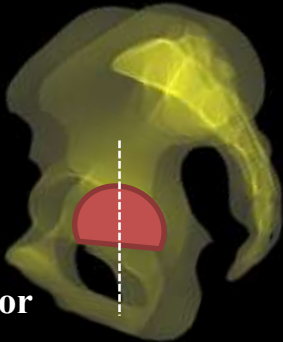
Sacral Slope



Pelvic Tilt



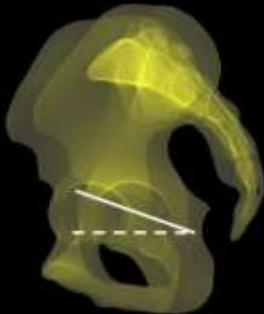
Posterior and anterior coverage of the femoral head by the acetabulum (%)



Acet. Anteversion (°)



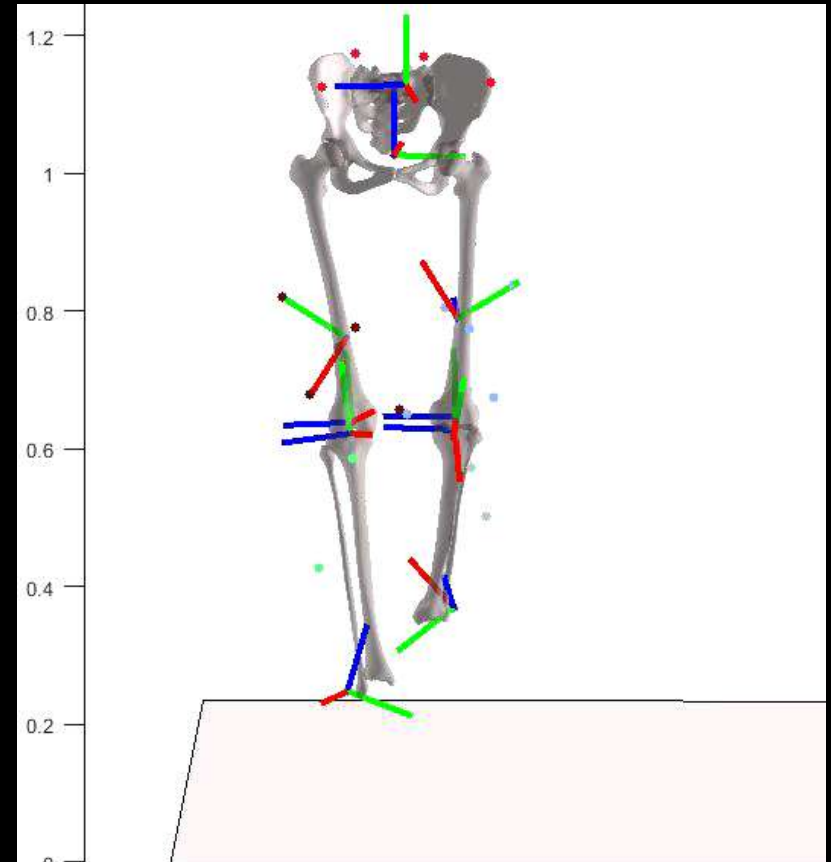
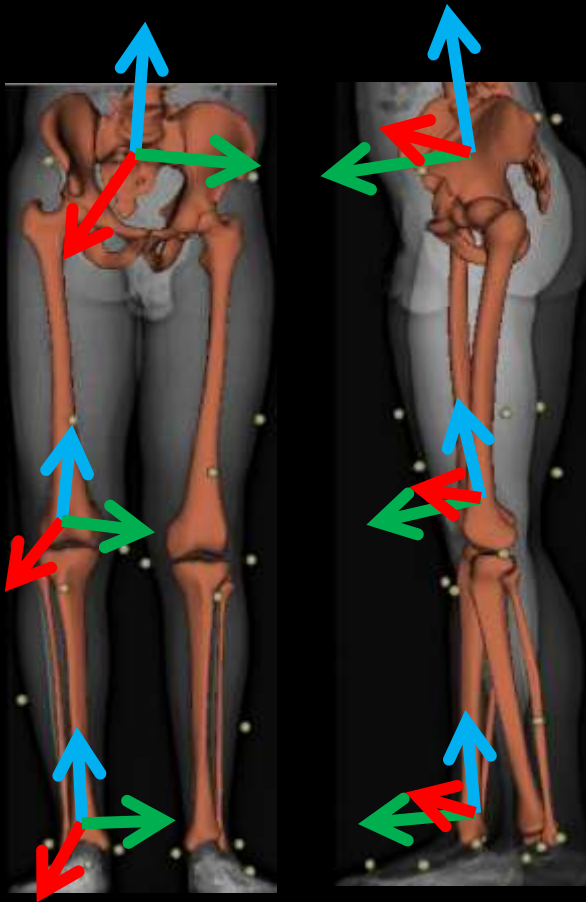
Acet. Inclination (°)



Acet. Tilt (°)

Validity and Reliability evaluated:
Ghostine et al., Eur. Radiology, 2016

Image Registration Technique



Computation of pelvic & acetabular parameters at each frame during gait cycle

STA reduction was performed using FEM

Sagittal Vertical Axis calculation during gait

- Based on the 3D position of C7 marker



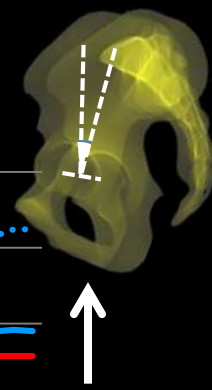
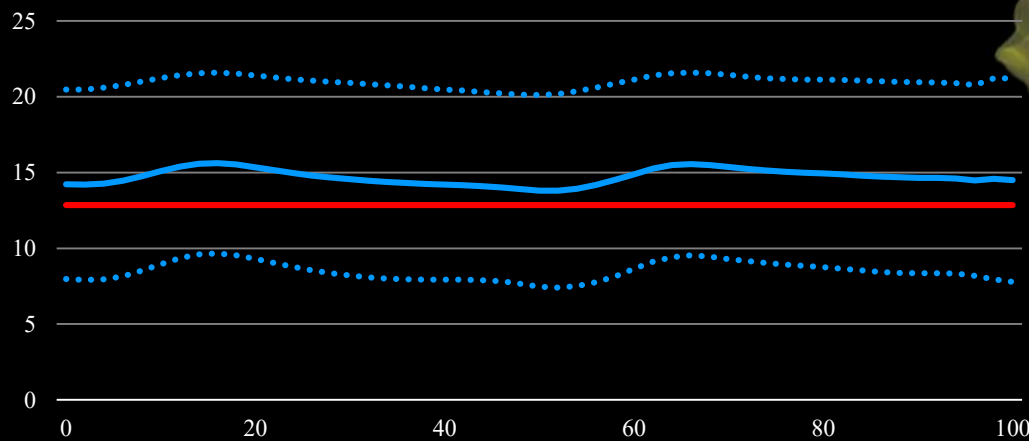
Analysis

- Kinematics of SVA, pelvic & acetabular parameters during gait:
 - Corridors of normality :
mean \pm 1SD
 - Range Of Motion (ROM)
 - Comparison with radiological value

Results & Discussion

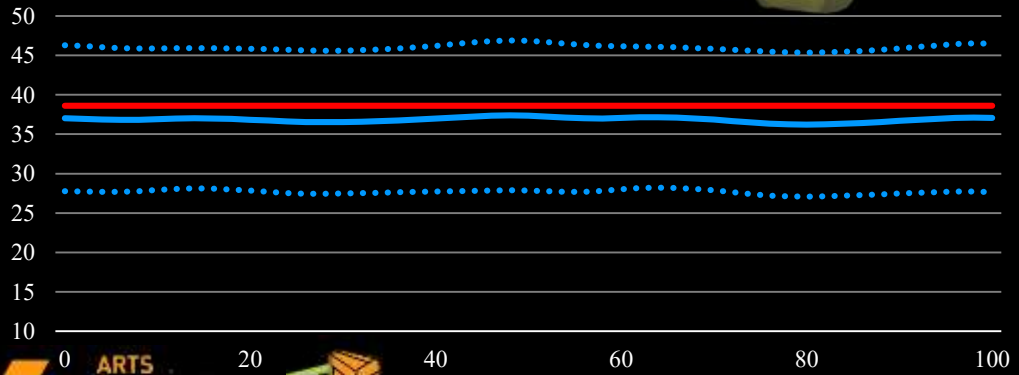
Pelvic parameters in TD

Pelvic Tilt



— Average — Radiological
 Average+SD Average-SD

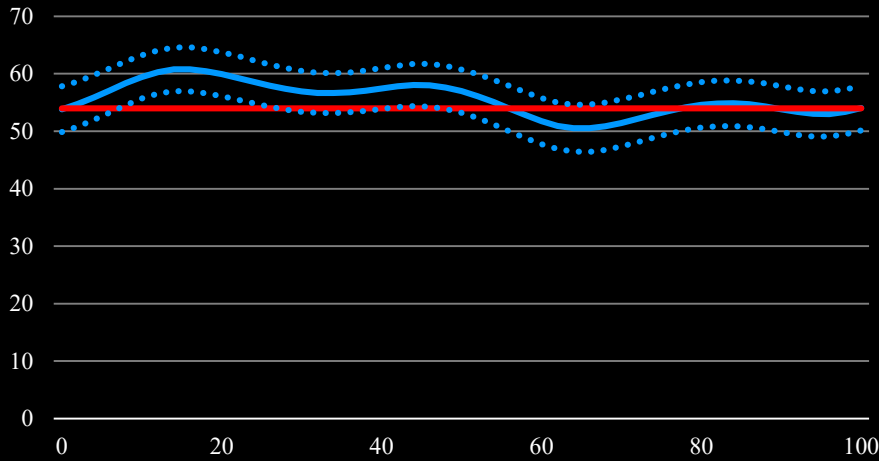
Sacral Slope



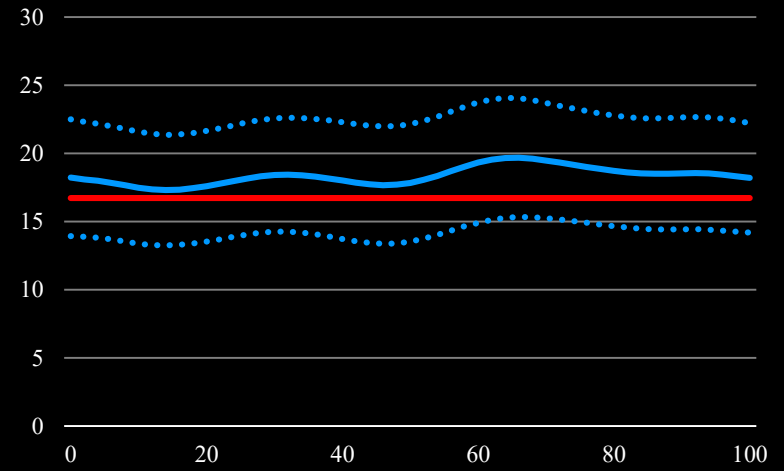
Biomechanical adaptations from standing to walking

Acetabular parameters in TD

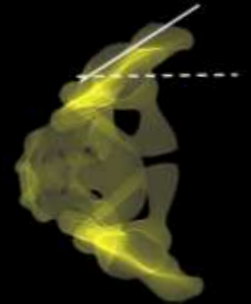
Abduction (°)



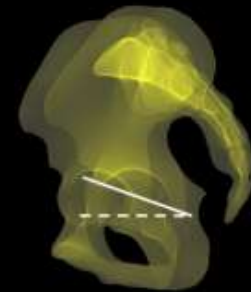
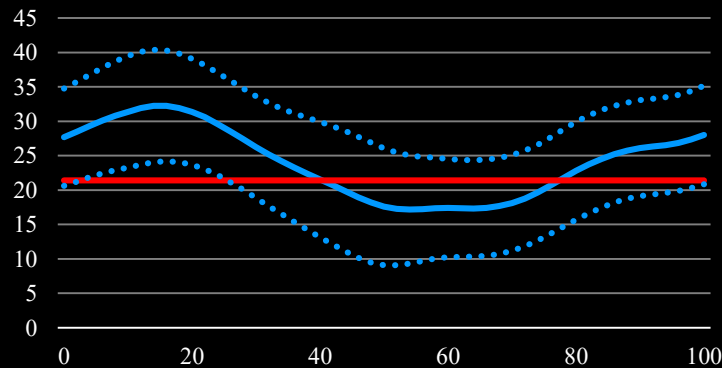
Anterversion (°)



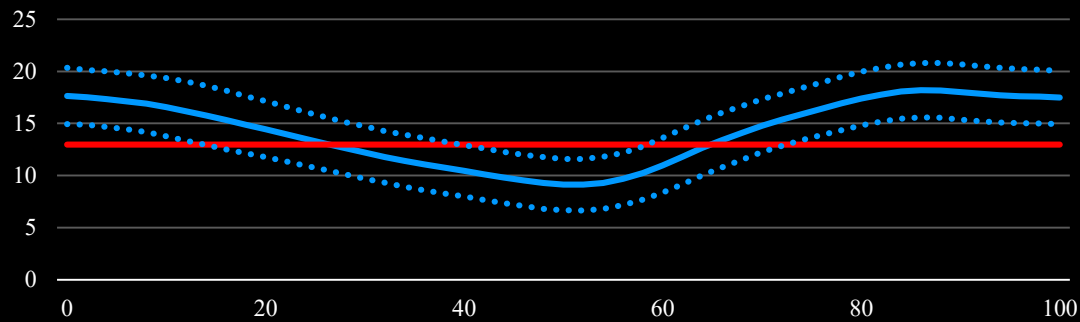
— Average — Radiological
⋯ Average+SD ⋯ Average-SD



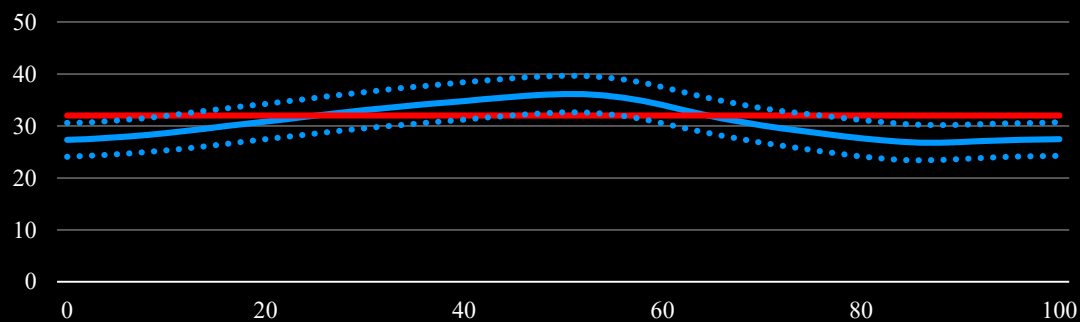
Acetabular Tilt (°)



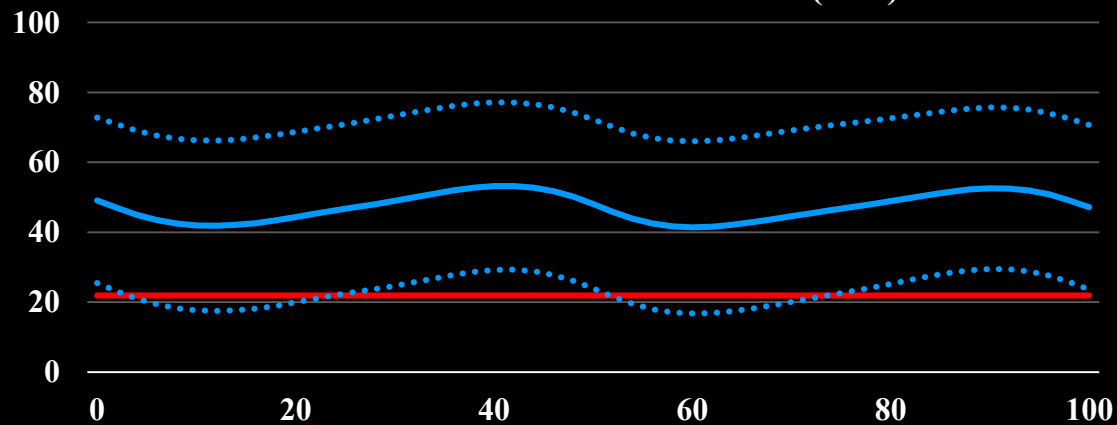
Anterior FH Coverage (%)



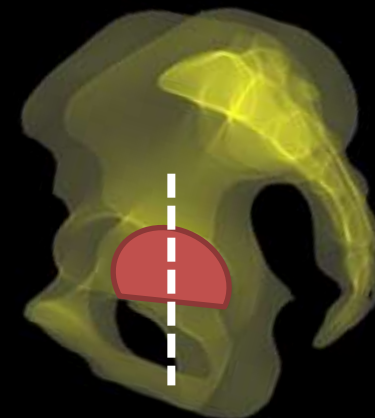
Posterior FH Coverage (%)



SAGITTAL VERTICAL AXIS (mm)



— Average — Radiological
..... Average+SD Average-SD



Conclusion

- This is the first study to describe variation of postural parameters during walking.
- Walking, an essential activity of daily living, seems to necessitate an anterior shift of the trunk (increased SVA), a slight increase in PT, in addition to a large range of movement of the pelvis frontally and axially, associated with a variation of the coverage of the femoral head by the acetabulum anteriorly and posteriorly.
- The corridors of normality of postural parameter variation during walking, established in this study, could be useful in the evaluation of dynamic alterations in subjects with spinal deformities.



Conflict of interest: None

