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O 061—How does the variation of the 3D orientation of the acetabulum during walking influence hip kinematics?

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1. Introduction

Acetabular cup orientation is crucial for total hip arthroplasty (THA), and its malpositioning could lead to impingement and dislocation [1]. Acetabular cup orientation currently relies on static 3D hip

parameters [2] and was shown to be related to changes in pelvic positioning [3]. While pelvic position varies during walking, it is still unknown how dynamic variation of hip orientation during gait could influence hip kinematics.

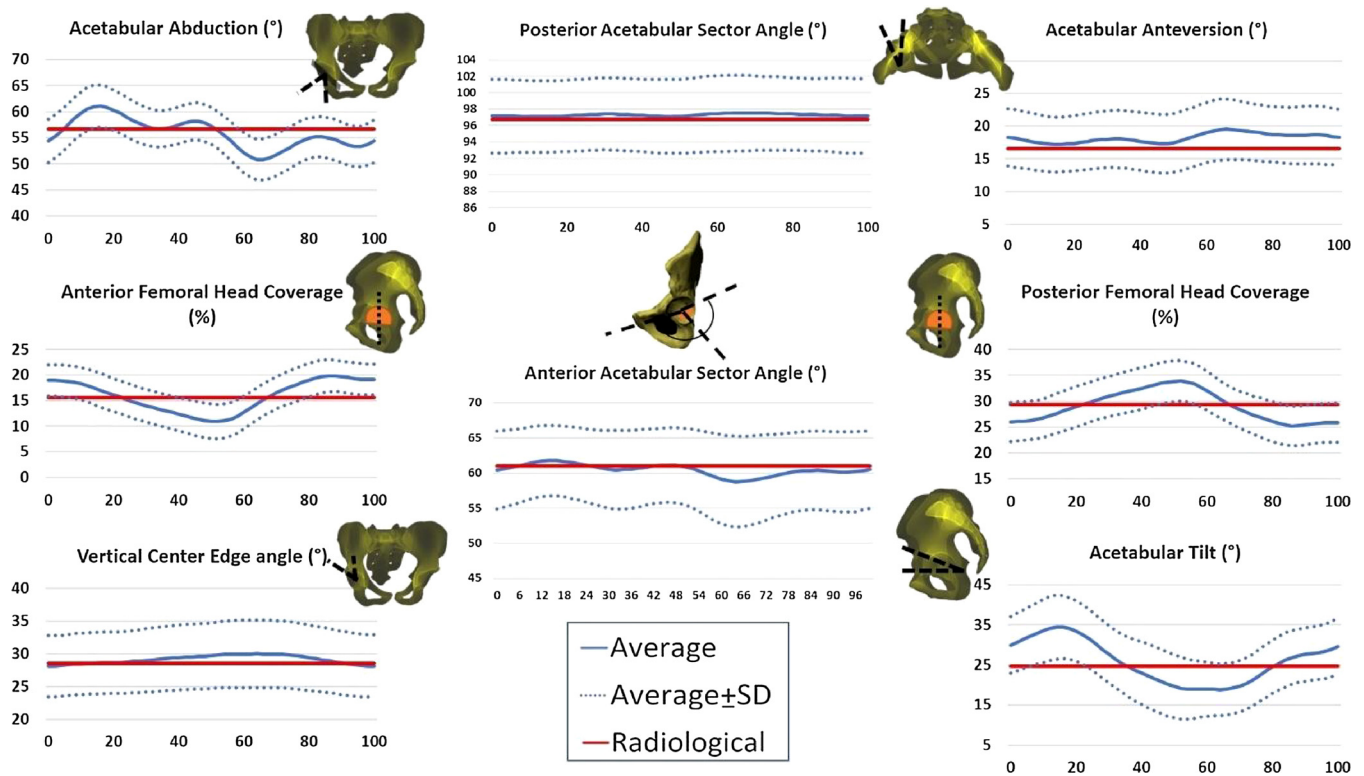


Fig. 1. 3D hip skeletal parameters computed during the gait cycle.

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2. Research question

How do dynamic variations of 3D skeletal hip parameters during gait influence hip kinematics in asymptomatic subjects?

3. Methods

77 asymptomatic subjects (age: 28 ± 10 years [18–38], 32F) underwent 3D gait analysis [4], with additional markers on thighs and shanks, from which the means, maxima, minima, and ROM of hip kinematics were extracted. Then, subjects underwent full-body biplanar X-rays with markers still in place. Full body 3D reconstructions were obtained for the spine, pelvis and lower limbs. The 3D bones were registered at each frame of the gait cycle [5]. A new technique developed for this study, utilizing finite element modelling, was used to reduce soft tissue artefacts. Then, 3D hip skeletal parameters (acetabular orientations, coverage of the femoral head by the acetabulum and sector angles) were computed during the gait cycle, using the 3D registered bones, at each time frame (Fig. 1): means, maxima, minima, and ROM were extracted. In order to assess the influence of demographic (age, sex, weight, and height) and dynamic variations of 3D skeletal hip parameters on hip kinematics during gait, a univariate analysis (Pearson’s correlation test) followed by a multivariate analysis (stepwise

multiple linear regression) were computed; the dependent variables were hip kinematics, while the independent variables were demographic and hip dynamic 3D skeletal parameters.

4. Results

ROM hip flexion/extension was determined by ROM_Posterior_Coverage ($r = 0.459, p < 0.001$). Maximum hip extension was determined ($R^2 = 0.226$) by weight ($\beta = 0.374, p = 0.001$), and ROM_Anterior_Coverage ($\beta = -0.241, p = 0.03$). Mean hip flexion/extension was determined by weight ($r = 0.446, p = 0.003$). ROM hip abduction/adduction was determined ($R^2 = 0.507$) by ROM_Acetabular_Abduction ($\beta = 0.668, p < 0.001$) and ROM_Vertical_Center_Edge_Angle ($\beta = 0.2, p = 0.022$). ROM hip internal/external rotation was determined by ROM_Posterior_Acetabular_Sector_Angle ($r = 0.347, p = 0.028$). Mean hip internal/external rotation was determined by ROM_Acetabular_Abduction ($r = 0.404, p = 0.005$).

5. Discussion

This is the first study to evaluate the effect of variation of 3D skeletal hip parameters during gait on hip kinematics (Figs. 2 and 3). A

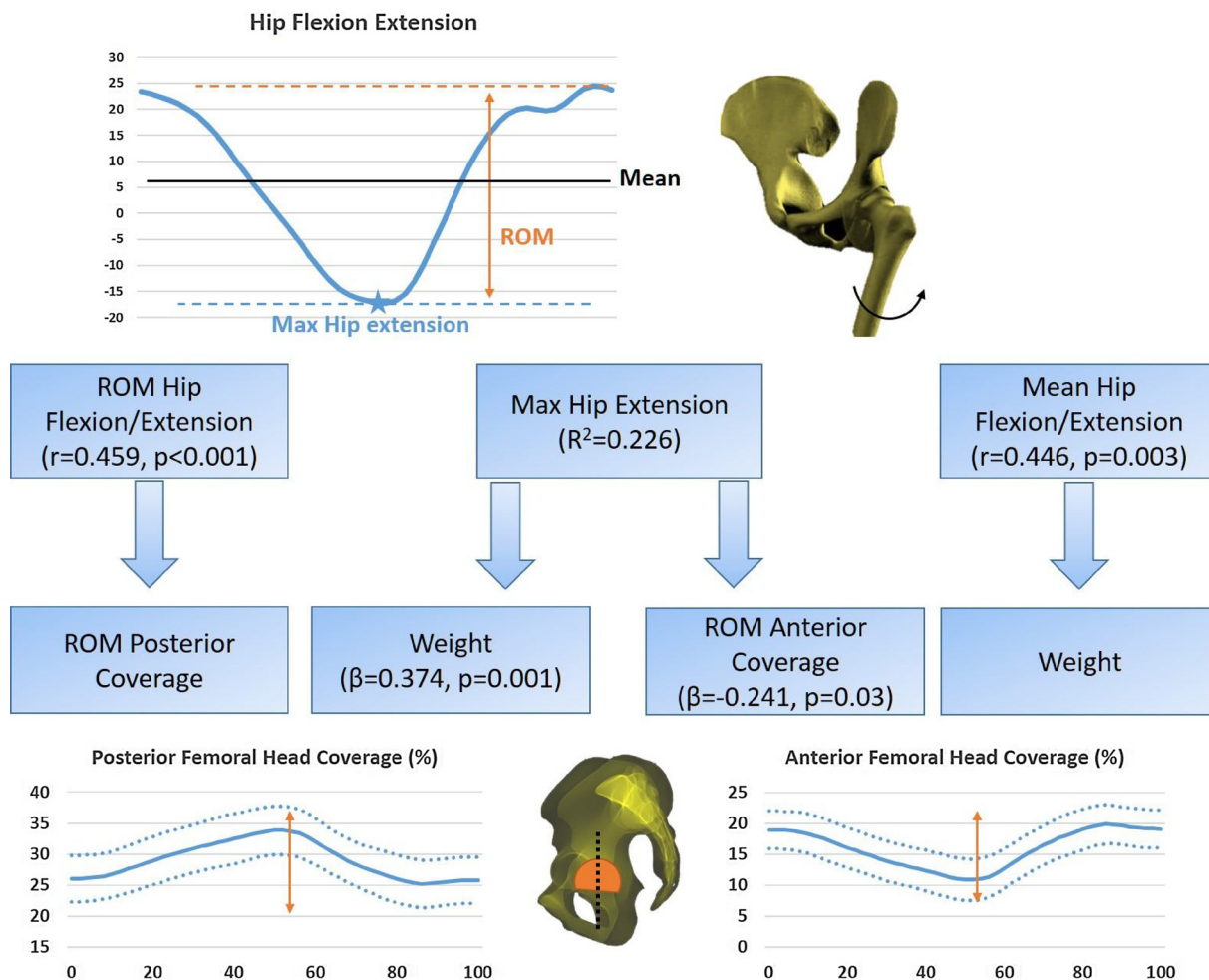


Fig. 2. Determinants of hip flexion/extension during gait among demographic parameters and 3D hip radiological parameters computed during gait.

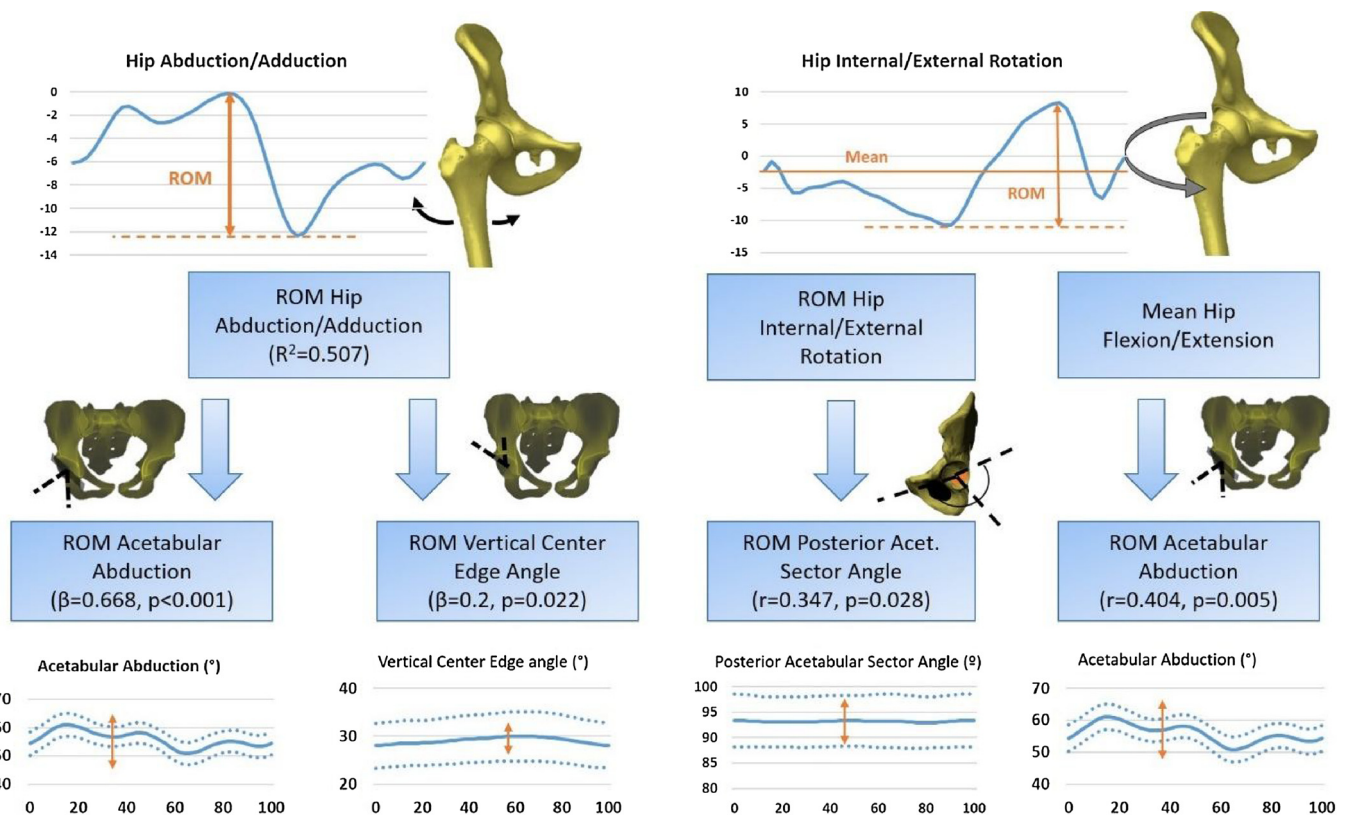


Fig. 3. Determinants of hip abduction/adduction and hip internal/external rotation during gait among demographic parameters and 3D hip radiological parameters computed during gait.

larger ROM of the posterior coverage and a smaller ROM of the anterior coverage of the femoral head by the acetabulum during gait seem to be related to a larger mobility of the hip in the sagittal plane. A larger ROM of the acetabular abduction during gait seem to be related to a larger mobility of the hip in both the frontal and axial planes. Planning acetabular cup orientation in THA should take into consideration these dynamic variations of the acetabulum during gait in order to ensure a full mobility of the hip during walking.

References

- [1] Teeter, 2018.
- [2] Bendaya, 2016.
- [3] Kanawade, 2014.
- [4] Davis, 1990.
- [5] Söderkvist, 1993.