O 028 - How do 3D skeletal parameters influence kinetics?

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1. Introduction

Lower limb joints are subject to mechanical load during daily activities, such as gait, which is an important risk factor of osteoarthritis. Moreover, kinetics are known to be influenced by gait alterations in patients with osteoarthritis [1]. While skeletal parameters are known to determine gait kinematics [2], it is still unknown how skeletal parameters influence kinetic parameters.

2. Research questions

How do 3D skeletal parameters influence lower limb kinetics in asymptomatic adults?

3. Methods

130 asymptomatic subjects with a large age range (age: 30 ± 11years [18–59], 63 F) underwent 3D gait analysis, from which

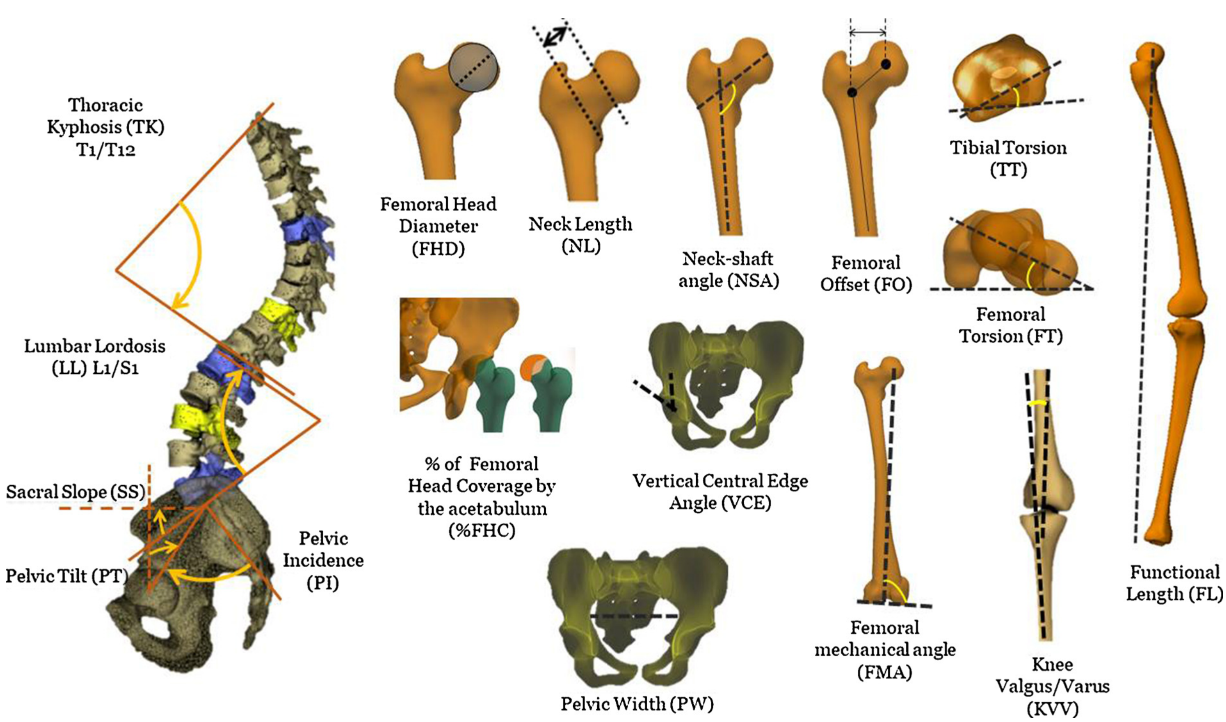

Fig. 1. 3D spino-pelvic, hip and lower limb parameters obtained from the full-body biplanar X-rays.

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Table 1
The main determinants of kinetics (moments and powers) during gait.

	Kinetics	Determinants	β	p-value
Moments in the sagittal plane	Mean Hip moment	Femoral Torsion	r = 0.177	0.007
	Mean Ankle moment (R^2 = 0.18)	T4-T12	0.150	0.014
		LL Functional length	0.318	< 0.001
		Tibial torsion	0.222	< 0.001
Moments in the frontal plane	Mean Hip moment (R^2 = 0.429)	Pelvic width	0.634	< 0.001
		Femoral offset	−0.229	< 0.001
		Sex (F)	0.045	< 0.001
	Mean Knee moment (R^2 = 0.191)	Pelvic tilt	−0.185	0.002
		Thoracic kyphosis	−0.183	0.002
		Knee Varus	−0.226	0.001
		Femoral mechanical angle	−0.136	0.046
		Vertical center edge angle	−0.167	0.006
Powers	Maximum Hip power (R^2 = 0.042)	Age	0.178	0.006
		Sex (F)	0.131	0.043
	Mean Knee power (R^2 = 0.174)	Lumbar Lordosis	−0.164	0.010
		Neck length	0.183	0.018
		Acetabular coverage rate	0.250	< 0.001
		Sex (F)	−0.161	0.037
	Maximum Ankle power	Tibial torsion	r = -0.16	0.012

the means and maxima of kinetic parameters (moments in the 3 planes and power) of hip, knee and ankle were extracted using the Davis protocol. Subjects then underwent full-body biplanar X-rays, from which 3D spino-pelvic, hip and lower limb parameters were obtained (Fig. 1) such as: Pelvic Tilt (PT), Sacral Slope (SS), Pelvic Incidence (PI), Lumbar Lordosis (LL), Thoracic Kyphosis (TK), Pelvic Width (PW), Femoral Head Diameter (FHD), Femoral Offset (FO), Neck Length (NL), Neck Shaft Angle (NSA), Tibial Torsion (TT), Femoral Torsion (FT), Functional Length (FL), Knee Valgus/Varus KVV, Femoral Mechanical Angle (FMA), Vertical Central Edge angle (VCE), % of Femoral Head Coverage by the acetabulum (%FHC) and acetabular orientation in the 3 planes. In order to assess the influence of skeletal and demographic (age, sex, weight, height and BMI) parameters on gait kinetics, a univariate analysis (Pearson's correlation) followed by a multivariate analysis (stepwise multiple linear regression) were computed; the dependant variables were kinetic parameters, while the independent variables were skeletal and demographic parameters.

4. Results

The results of the most significant outcomes are shown in Table 1. In the frontal plane, the mean hip moment (R2 = 0.429) was determined by FO (β = −0.299, $p < 0.001$), PW (β = 0.634, $p < 0.001$) and sex (β = 0.045 F compared to M, p = 0.045); the mean knee moment (R2 = 0.191) was determined by PT (β = −0.185, p = 0.002), TK (β = −0.183, p = 0.002), KVarus (β = −0.226, p = 0.001), FMA (β = −0.136, p = 0.046) and VCE (β = −0.167, p = 0.006). The maximum ankle power was determined by TT (r = −0.176, p = 0.007).

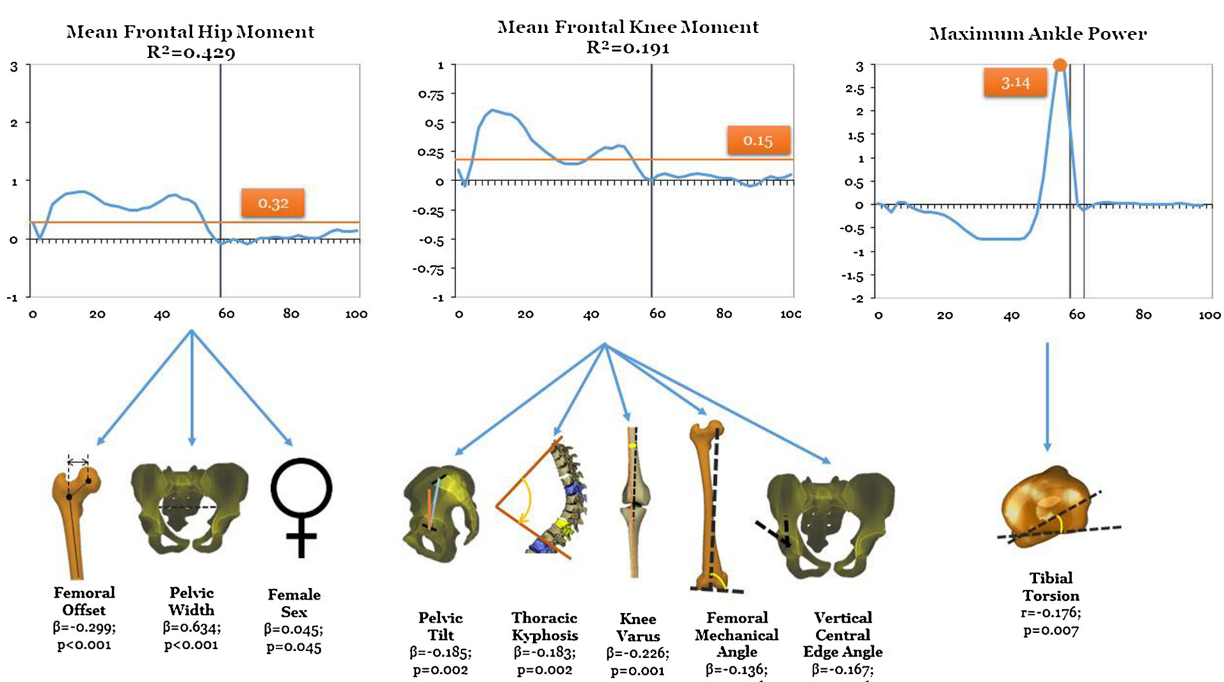

Fig. 2. The impact of skeletal and demographic parameters on lower limb moments and powers during gait.

5. Discussion

This is the first study to investigate the impact of skeletal and demographic parameters on lower limb moments and powers (Fig. 2). Females with a larger PW showed greater frontal hip moment during gait, which was shown to be related to radiographic progression of hip osteoarthritis [[3]]. Subjects with smaller pelvic tilt, thoracic kyphosis, knee varus, femoral mechanical angle, and vertical central edge angle seem to have a greater frontal knee moment and thus might be at risk of developing knee osteoarthritis.

References

[1] Wesseling et al. 2015.
[2] Bakouny et al. 2017.
[3] Tateuchi et al. 2017.