

Efficacy of using the pelvic method to estimate centre of mass position in response to gait perturbations

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Introduction

During gait the centre of mass (COM) should be maintained relative to the base of support for optimal efficiency of movement, and reduced risk of falling [1]. The ability to control the COM position is challenged for every step, and is therefore an important tool in clinical practice to predict dynamic stability [2].

To ensure accuracy and precision of COM estimation, motion analysis equipment and full body (FB) tracking is required [3]. Difficulty implementing this due to time and expertise limitations causes clinicians to favour the pelvic model (P), assuming the COM can be represented by the centre point of the pelvis. This may trade accuracy and precision for clinical applicability [4]. The aim of this study was to investigate COM representation during unperturbed and perturbed gait using a reduced kinematic model.

Research Question

Does a reduced kinematic model represent the COM during unperturbed and perturbed gait?

Method

All testing was conducted on the CAREN Extended System (Motek Medical, The Netherlands). The full Human Body Model [4] was applied to each able-bodied participant (n=17). At a pre-determined comfortable pace each participant walked on a treadmill, encountering mediolateral (ML) and anteroposterior (AP) destabilising perturbations (figure 1).

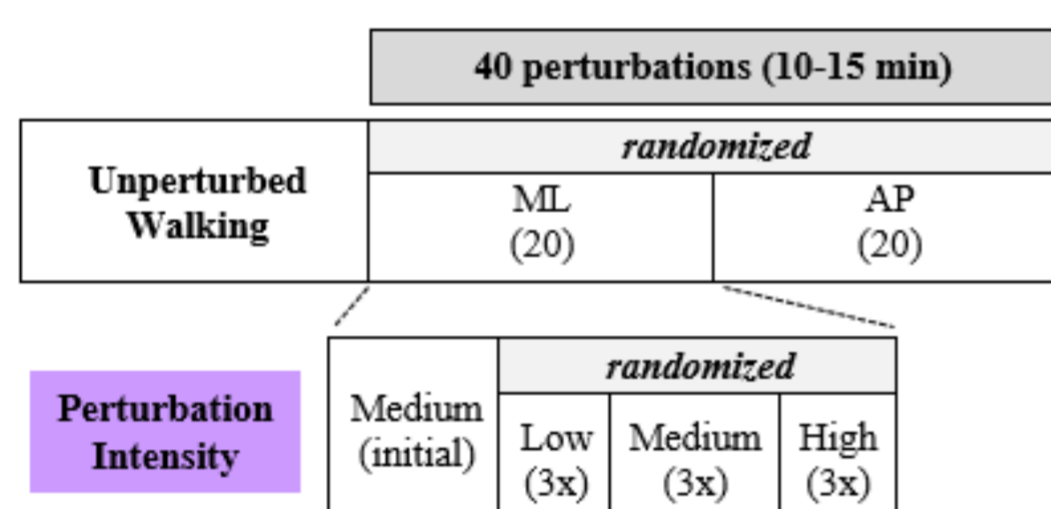


Figure 1. Schematic overview of the perturbation protocol. (10) indicates number of perturbations per trial.

Segmental analysis determined the COM of the FB and P models over 80 gait cycles. Limits of acceptability (LoA) were $\pm 2SD$. Statistical significance was set at 95% confidence intervals.

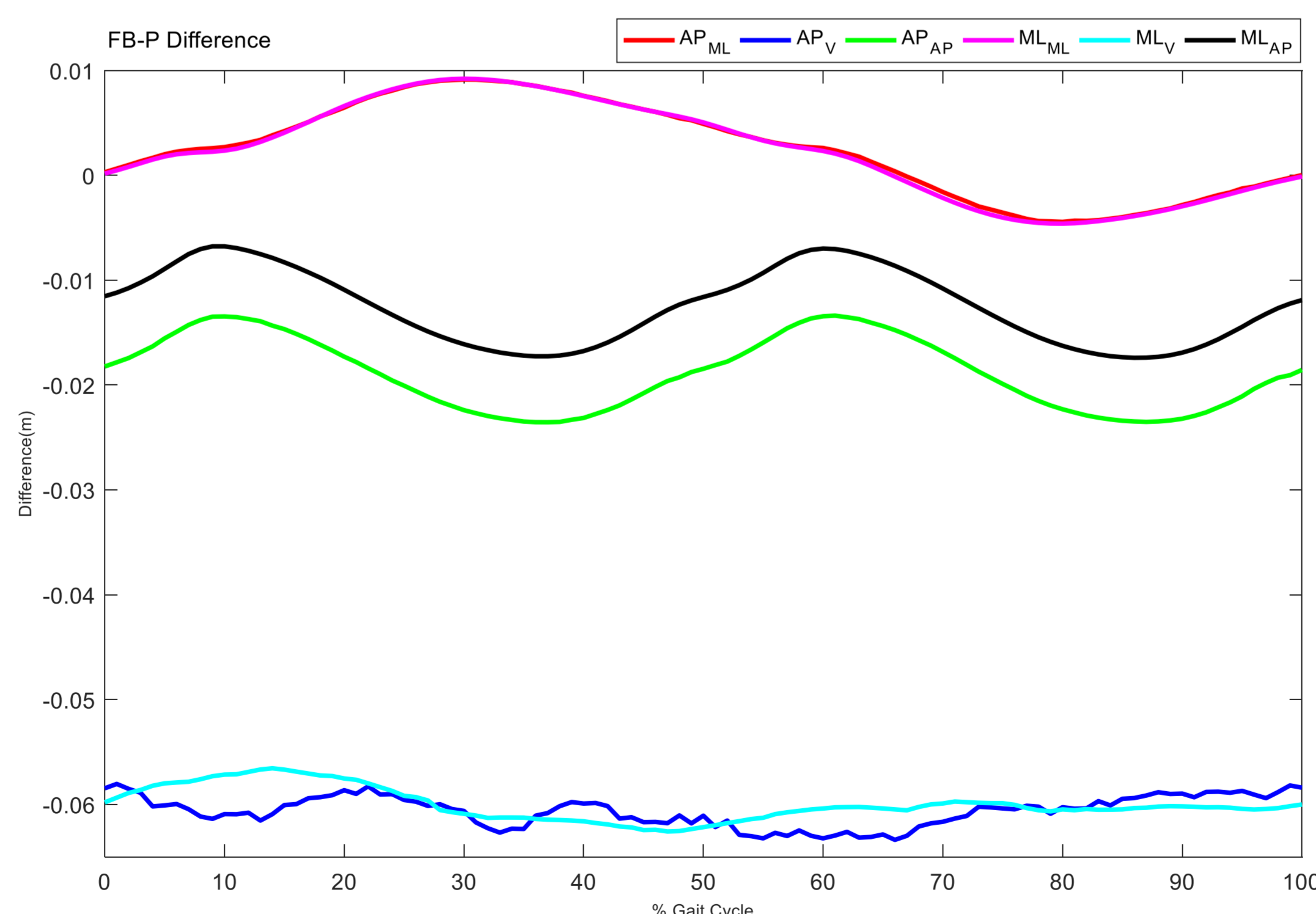


Figure 2. Average difference of the vertical COM position between FB and P models over 1 gait cycle.

Results

Mean resultant distance was $0.06 \pm 0.0m$ ($p > 0.05$) between FB and P models during the gait cycle, affected by the vertical difference (fig. 2). In the ML direction this did not significantly differ ($p = 0.949$) and the variance in all trials remained within the LoA. For both the ML and AP perturbations the greatest deviation occurred in the AP direction, resulting in a 1.7cm and 2.4cm maximum, respectively, during 35-40% and 85-90% of the gait cycle. For the ML trial the greatest deviation ML was 0.9cm.

Table 1. Mean ML distance (SD) between FB and P model at initial contact.

Trial	Mean Distance at Initial Contact (m) (SD)	
	ML	
NOR	-0.002 (0.01)	
AP	0.000 (0.01)	
ML	0.000 (0.01)	

*indicates significant difference from FB model ($p < 0.05$)

Discussion

Results suggest reliable COM estimation using the P model. This supports previous research showing comparable accuracy and precision at the most unstable point of gait [6] and throughout the gait cycle using reduced kinematic models [2].

This presents the opportunity for dynamic stability to be quantifiably measured using a simple and efficient protocol, appropriate for clinical practice, without trading accuracy and precision.

- References**
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