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Short communication

P 053—The use of the ankle strategy to restore balance during perturbed walking

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1. Introduction

Stability during walking can be maintained by moving the Center of Pressure(CoP), in such way that the Center of Mass(CoM) remains within the Base of Support(BoS). One possible strategy to do this, is the ankle strategy, i.e. by generating a torque around the ankle [1,2]. The ankle strategy is expected to be employed for unperturbed walking and standing and for slow and low amplitude perturbations [3–5]. It is unclear to what extent perturbation magnitude will affect the ankle strategy (specifically, the three-dimensional peak ankle torques) in healthy adults.

2. Research question

What perturbation and perturbation magnitude will significantly affect the peak ankle torques in healthy adults?

3. Methods

Ten healthy subjects (5 male, 5 female, mean age 25 ± 2.0 years) performed 20 trials of unperturbed and perturbed walking at fixed speed(1.2ms-1), on a Gait Real-time Analysis Interactive Lab (GRAIL;Motek bv). All trials contained 15 perturbations (either a belt acceleration(AC) or deceleration(DC)), of which magnitude (5 possible magnitudes, ranging from 0.1-0.5 m/s2) and number of steps between subsequent perturbations were randomly varied. Perturbations were applied immediately after right heel strike and finished within the right stance phase. Three-dimensional peak ankle joint torques (plantar-flexion, inversion, abduction), normalized to the participants' body mass and height, were calculated from the full body kinematics (using Vicon camera 3D motion analysis system[Oxford]) and kinetics. A repeated measures ANOVA was performed to determine the effect of perturbation magnitude (none-0.5 m/s2) on peak plantar, inversion and abduction ankle torques. Post-hoc analyses using Bonferroni correction were performed to determine differences between conditions. Statistical analyses were performed with SPSS(v23) at $\alpha < 0.05$.

4. Results

Only for the deceleration perturbation, peak inversion ankle torque decreased significantly from unperturbed walking to perturbed walking with increasing perturbation magnitude($p = 0.02$,Fig. 1a). Post-hoc analysis revealed no significant differences.

5. Discussion

With increasing perturbation magnitude (of a sudden deceleration of the right belt), peak inversion ankle torque decreased significantly, indicative of altered reliance on the ankle strategy. Nevertheless the post-hoc tests did not reveal significant effect. A possible explanation for the absence of effects in peak ankle torques could be that another balance control strategy was used by participants, e.g. the counter-rotation mechanism [1], or foot placement [2]. In the former strategy, parts of the trunk are rotated with respect to the CoM [5]. The hip strategy is an example of this mechanism. The hip strategy is expected to be employed for fast or larger amplitude perturbations compared to the ankle strategy [6]. However, it could also be that the perturbations intensities were too light to detect peak ankle torque differences

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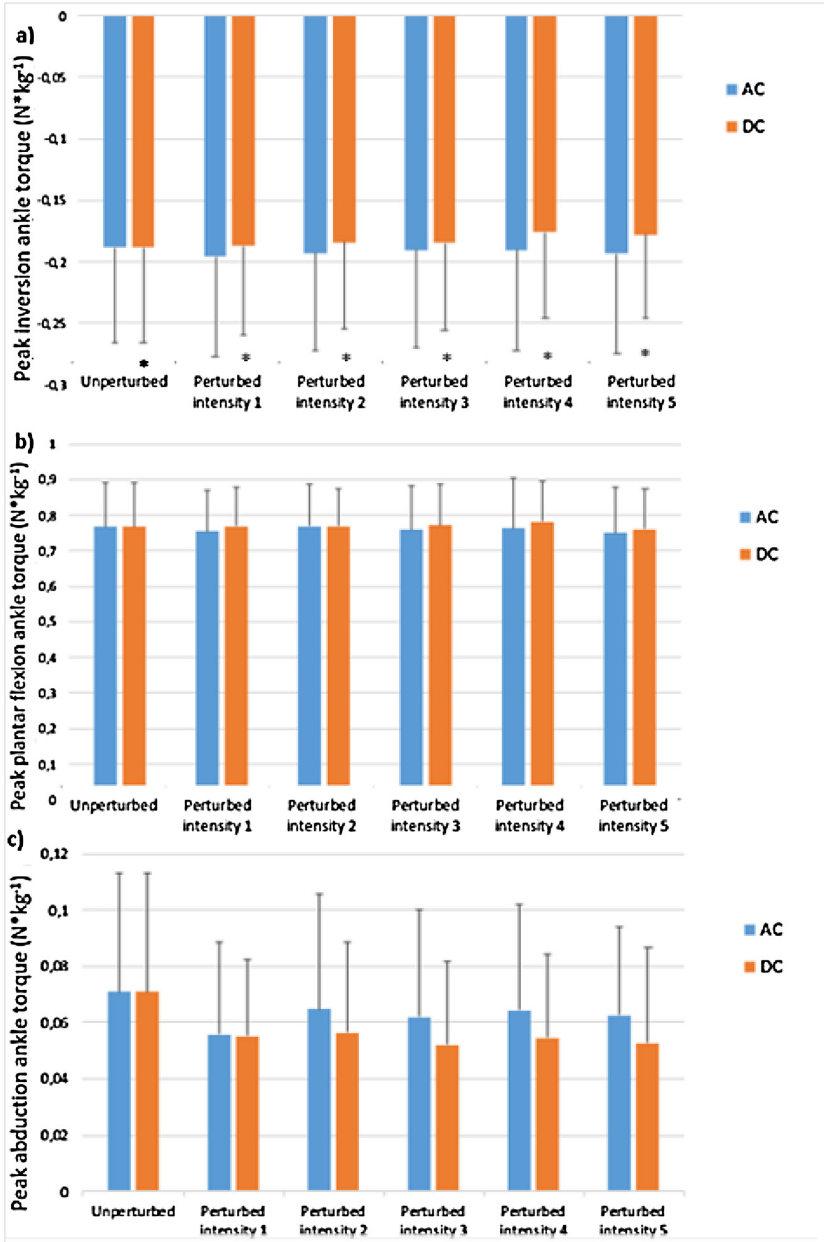

Fig. 1. a) Peak inversion, b) peak plantar flexion and c) abduction ankle torques during unperturbed and perturbed walking [a].
[a]An asterisk (*) means significant main effect of condition, $p < 0.05$.
AC = acceleration, DC = decceleration, INV = inversion, PF = plantar flexion, ABD= abduction.

between the perturbation intensities. Future research should focus on determining the contributions of the different mechanisms to maintain balance during perturbed walking.

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