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Lower limb energetics in leg length discrepancy

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Objective
To investigate effects of LLD severity and center of mass (CoM) position on energetics of lower limb during level walking because the relationship between LLD and lower limb energetics are unclear.

Methods
Thirty one participants with LLD more than 1 cm were included in the analysis. We excluded participants with neurologic or orthopedic problems which could disturb walking, such as cerebral palsy, LCP, focal peripheral neuropathy, joint contracture etc. Participants walked on 8m level walkway with 2 force plates. 3D motion analysis was conducted. We obtained gait parameters (temporo-spatial, joint angle, joint moment, joint power, external work, and IA (inclination angle) between CoM and CoP) (Fig 1). External power (EP) and external work (EW) were compared between shorter and longer limbs with paired t-test (Fig 2). LLD severity (difference between both limbs) and IA effects on EP and EW were investigated with linear regression model.

Results
Negative EW showed significant difference between longer limb (-2.13±0.71) and shorter limb (-1.79±0.98). In shorter limb, LLD severity showed significant relationships with positive EP ($R^2 = 0.375$, slope = -0.002, $p = 0.001$), negative EW ($R^2 = 0.543$, slope = 0.051, $p < 0.001$) and positives EW ($R^2 = 0.429$, slope = -0.048, $p < 0.001$). In longer limb, LLD severity showed significant relationships with, negative EW ($R^2 = 0.263$, slope = 0.029, $p < 0.013$) and positives EW ($R^2 = 0.416$, slope = -0.027, $p < 0.001$). These significant relationships in linear model were on the control of walking speed. In shorter limb, maximal and minimal IA did not show significant relationships with negative EP, positive EP, negative EW and positive EW. In longer limb, minimal IA showed significant relationship with negative EP ($R^2 = 0.2682$, slope = 0.2837, $p = 0.012$). Minimal IA in smaller and longer side did not show significant relationships with LLD severity.

Conclusion

Larger limb length discrepancy induces smaller negative and positive external work, indicating smaller energy absorption and generation. Compensation strategy shifting CoM to longer side may increase negative work in longer limb.

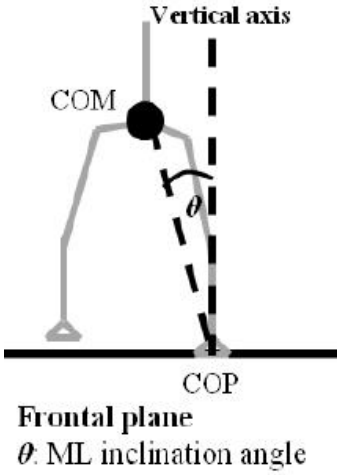

Figure 1. Inclination angle between CoP and CoM in frontal plane

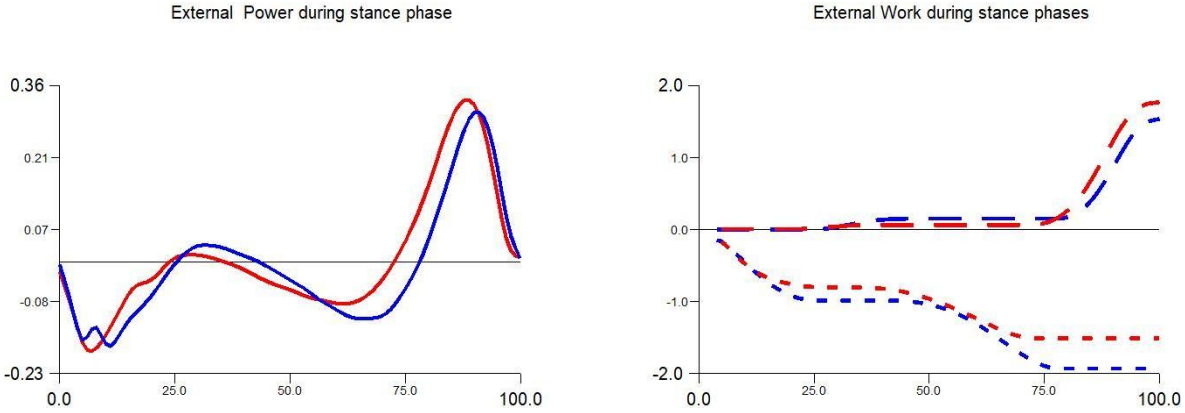

Figure 2. External power (W·Kg-1) and external work (J·Kg-1) during normalized stance phase. External work indicates body work for moving center of mass. Blue = right lower limb, red = left lower limb. In external work, positive graph means cumulative generative work and negative graph means cumulative absorptive work during stance phase.