Functional Strength Training May Improve Distribution of Joint Power during Walking in Postmenopausal Women.

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Summary

A characteristic feature of aging gait is a shift in joint work from the distal to the more proximal joints. The purpose of this study was to examine the effects of a functional strength training intervention on this shift in the walking mechanics among postmenopausal women. Seven subjects completed gait analyses before and after an 8-week training program. Changes in relative hip and ankle work to the total limb were negatively correlated, indicating that functional strength training has potential to modify the distribution of joint power.

Introduction

Aging is characterized by physiological changes that alter walking gait mechanics and slow gait speed, compromising mobility and increasing fall risk. Reduced gait speed is accompanied by a redistribution of joint mechanics that is exemplified by decreased ankle joint work and increased hip joint work. Traditional resistance training increases strength and gait speed but has not improved distal-to-proximal shift of joint power (D2P) [1], possibly due to the lack of task specificity in traditional strength training programs. We propose that D2P may be better attenuated by functional strength training programs that include movements resembling tasks of daily living. Given that postmenopausal women experience blunted responsiveness to exercise training compared with men [2], it is important to understand how functional strength training may uniquely affect gait mechanics of this population. This study investigated the effect of a supervised, circuit-based training program on D2P in postmenopausal women. We hypothesized an increase in ankle work contribution to total lower limb positive work would arise following the 8-week intervention.

Methods

Seven postmenopausal women (age: 66 ± 5 years; BMI: 31.4 ± 3.9 kg/m^2) completed a progressive 8-week exercise program emphasizing functional activities over a period of 8-weeks at a frequency of 3 sessions per week. At baseline and follow-up, subjects completed a gait analysis and 6-minute walk test (6MWT) to estimate peak oxygen consumption ($\dot{V}O_{2peak}$). Inverse dynamics for ankle, knee, and hip joint power were calculated over the stance phase. Joint work was calculated as the integral of joint power. Total positive limb work was calculated as the sum of the positive work generated across the ankle, knee, and hip. Relative positive joint work (%) were calculated for hip to total limb (H:L) and ankle to total limb (A:L). Pre-post changes in joint work and 6MWT outcomes were compared using paired *t*-tests with Hedge's g effect sizes ($\alpha = 0.05$). Pearson correlations were used to test the relationship between changes in 6MWT and changes in joint work outcomes.

Results and Discussion

Gait speed significantly increased at follow-up by 0.06 ± 0.04 m·s^{-1} ($p = 0.01$). Estimated $\dot{V}O_{2peak}$ was significantly increased at follow-up ($p < 0.01$, $g = 2.31$). 6MWT outcomes were not related with any joint work outcomes ($p > 0.509$, $r < 0.137$). Despite moderate to large effect sizes for all joints (hip $g = -0.48$, knee $g = 0.66$, ankle $g = 0.34$), gait mechanics did not vary by timepoint ($p > 0.05$), likely due to the small sample size and varied subject responses. However, Similar to Hortobágyi et al. [3], we found an inverse relationship between A:L and H:L ($p < 0.001$, $r = -0.984$; Figure 1), indicating decreases in A:L were related to increases in H:L. Unlike the group mean in Beijersbergen et al. [1], we observed increased A:L and decreased H:L in 3 out of 7 participants.

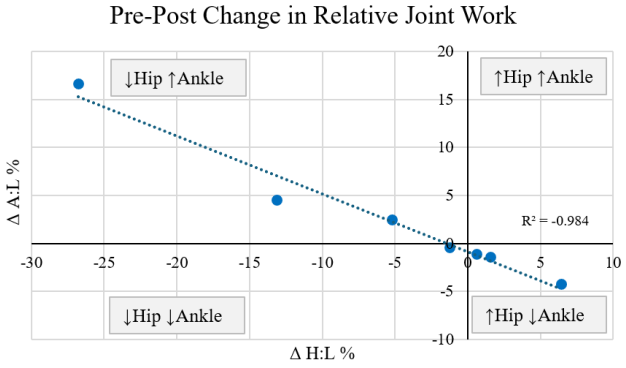

Figure 1: Change (Δ) in positive hip to total limb work (H:L) and ankle to total limb work (A:L) between baseline and follow-up. Grey boxes indicate four possible relative changes from baseline.

Conclusions

Changes in mechanical work contributions from the ankle and hip during gait were inversely correlated following an 8-week functional strength training intervention in postmenopausal women. Findings were limited by the small sample size and individual participant outcomes varied, but the trend in post-intervention joint work redistribution from proximal to distal in some subjects warrants further investigation to confirm the effects of functional strength training on improving D2P in aging populations. Overall, the results suggest a positive effect of the functional strength training intervention on D2P, gait speed, and estimated peak oxygen consumption.

References

[1] Beijersbergen et al. (2017), *Gait Posture,* **52**: 338–344.
[2] Moreau et al. (2017), *Exerc Sport Sci Rev*, **45**: 116-123.
[3] Hortobágyi et al. (2016), *Eur J Appl Physiol*, **116**:805-814.