Improvement of Balance Using Trunk Motion Visual Feedback Treadmill Walking for Older Adults: A Randomized Controlled Trial

KINESIOLOGY

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BACKGROUND

Older adults and many patient populations are at increased risk of falling, with high probability of those falls resulting in injury.[1,2] **Approximately one third to one half of the population over the age of 65 falls annually.**[3] **The estimated cost of fall related injuries in the United States per year is $23 Billion.**[4]

Despite advances in visual feedback for balance training. Majority of the training are performed while standing still. However, most falls occur during movement or during transitions from stationary positions to moving activities.[5] Virtual reality (VR) environments combined with treadmill gait training has been reported to improve walking ability.[6,7] Only recently have expensive VR treadmill systems been reported to improve balance while walking.[8]

Here we report on carry-over benefits from a low-cost VR system (TreadSense) with augmented visual feedback of trunk motion provided during treadmill walking which translated into improved dynamic balance and reduced trunk motion variability.

HYPOTHESIS

Visual feedback *(VFB) of trunk motion during treadmill walking will lead to greater improvements in balance and functional mobility than treadmill walking alone for older adults at risk for falling.*

Aims

Determine the effects of a randomized clinical trial intervention using trunk motion feedback during treadmill walking.

- Measurable changes in clinical assessments.
- Measurable kinematic changes in trunk orientation and center of mass (COM) translation.

METHODS

Pre-Test 1 | 4 Week Break | Pre-Test 2 | 4 Week Training | Post-Test

Clinical Assessments

(4 weeks apart)

- Mini-Mental State Exam (>24) (Pre-test 1 only)
- Activities-specific Balance Confidence (ABC) Scale [9]
- BESTest [9]
- Berg Balance Scale [10]
- Get up and Go (TUG) [9]

Kinematic Assessments

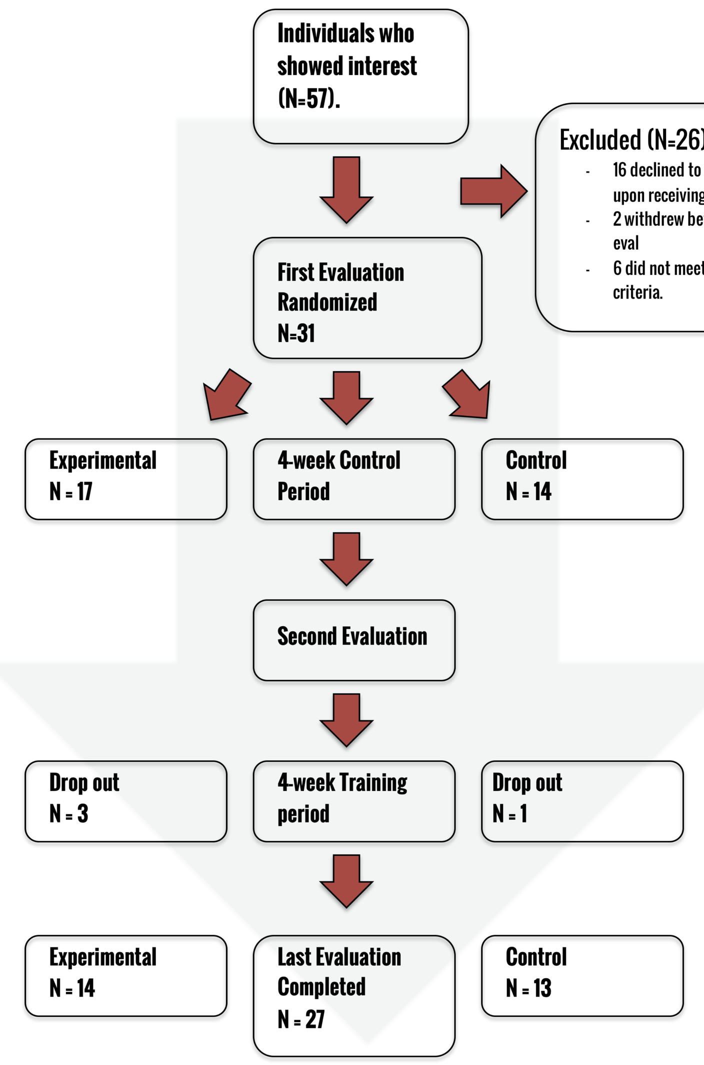
Medial-Lateral (ML) and **Anterior-Posterior** (AP) directions of:

- **Center of Mass** (COM) translation
- **Trunk Angle** (TA)

Statistical analysis

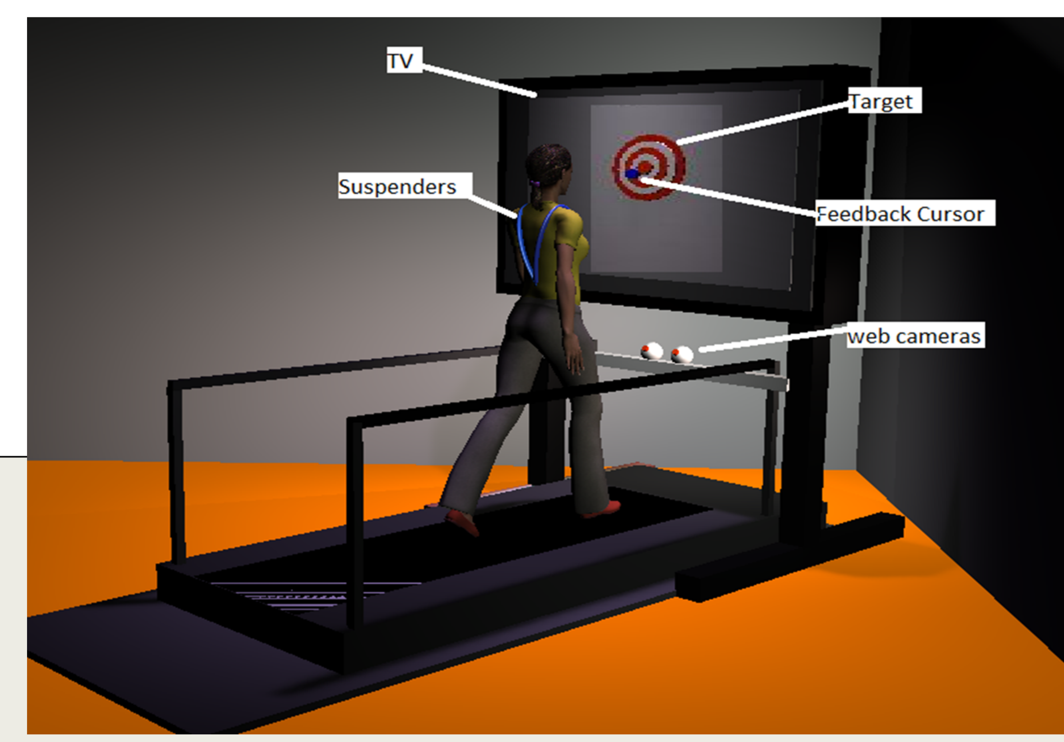
- ANOVA
- Paired T-tests (2-tail)

METHODS



Training Protocol

- **3x/week for 4 weeks**
- **Total training time of 30 minutes per day**
    - Including trial and rest times
    - 2 minute trials of treadmill walking follow by seated rest
    - Choice of 30 seconds, 1 minute, and 2 minute rests
- **Experimental group** (age = 77±5):
    - Randomly ordered **COM translation** or **trunk orientation to vertical** visual feedback
    - "Keep the cursor as close to the center of the bulls-eye as possible"
- **Control group** (age = 77±7):
    - Walking in front of a screen showing only bulls-eye.
- **All subjects walked at their "comfortable speed"**
    - Midpoint of self reported "too fast" & "too slow" speeds on each day of the training



RESULTS

BESTest score changes after training (Post-test – 2nd Pre-test)

Group	Mean (range)	Standard Error	P-value
Exp (n=14)	3.30	1.02	0.01
Control (n=13)	2.03	1.18	0.11

Changes in Berg Balance, TUG, and ABC (Post-test – 2nd Pre-test) • ANOVA and paired t-tests showed no significant changes.

Group	Berg Balance Test	TUG	ABC score
Exp	1.14 (S.E=1.00)	-0.20 (0.30)	-1.61 (2.7)
Control	0.46 (0.40)	-0.56 (0.33)	-2.30 (4.3)

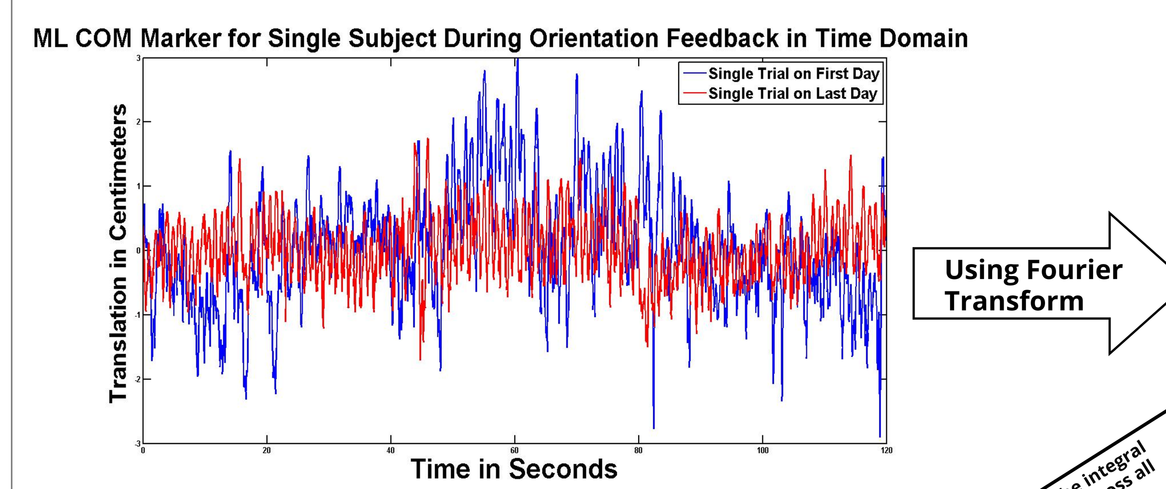


Figure 1. ML COM translation for a single subject's first day and last day trials with orientation feedback.

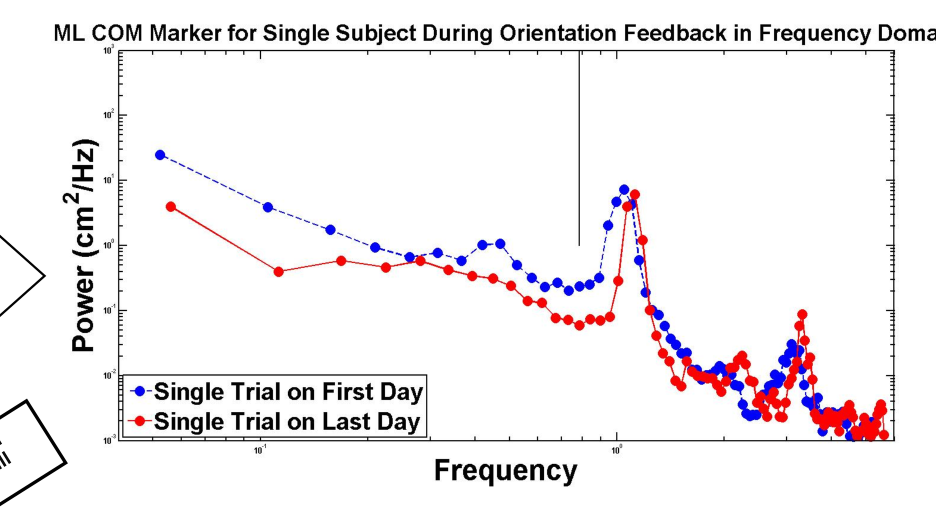
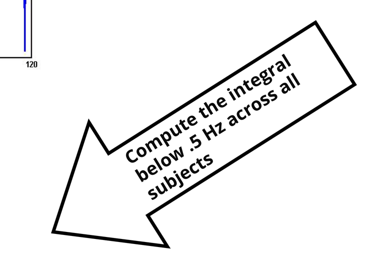
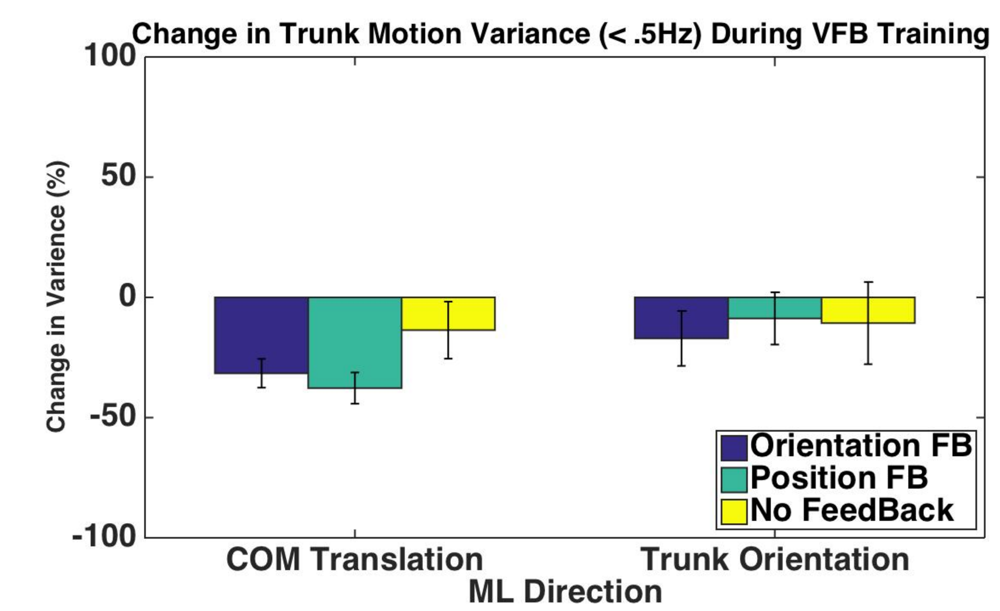


Figure 2. COM power in ML directions of a single subject's first day vs last day trials with orientation feedback. Vertical line represents point at .5 hertz.





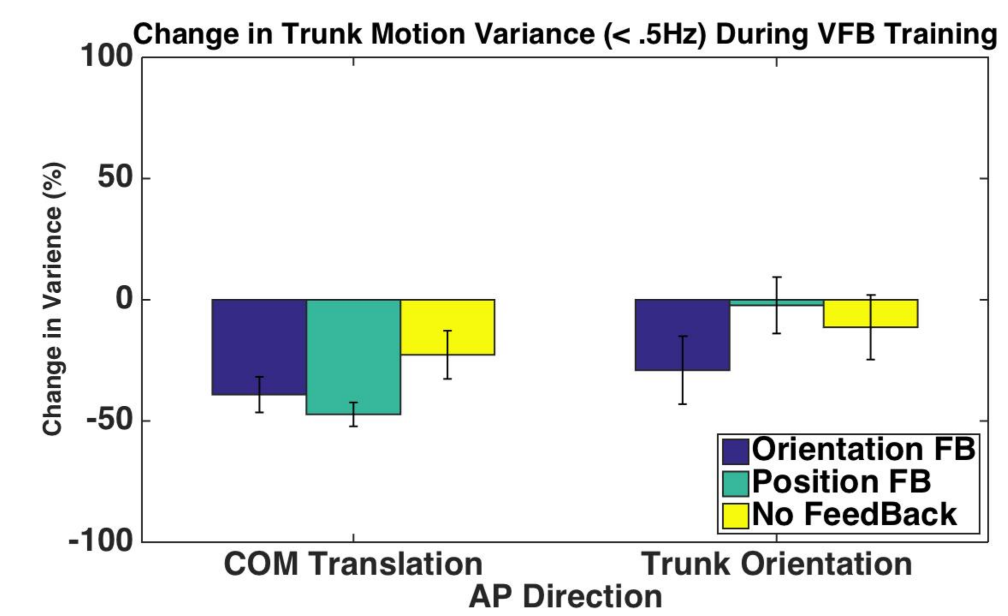


Figure 3 and 4. Difference of first 3 days VS last 3 days mean variance below .5Hz for all subjects. Greater reduction in low frequency movement is shown in COM translation in both AP and ML directions during VFB training. Greater reduction in low frequency movement of trunk orientation are shown in orientation FB and no feedback conditions.

CONCLUSION

- Using VFB to minimize trunk motion resulted in measureable changes in standing and walking balance ability.
- Reduction in COM translation during visual feedback training could suggest improved COM control during walking.
- Reduction in trunk orientation variability could be an effect of increasing familiarity with the treadmill walking training, since it was present in both groups.

Future

Q: Does augmenting traditional balance rehabilitation with VFB during walking result in greater balance improvements in a shorter period of time?

Q: Does increasing speed of the treadmill with VFB training induce additive improvement in balance?

REFERENCES

1. Committee on Trauma, & American College of Surgeons. (2014). Statement on older adult falls and falls prevention. *Bulletin of the American College of Surgeons*, 99(9), 47.
2. Chang, H. J., Lynm, C., & Glass, R. M. (2010). Falls and older adults. JAMA: *The Journal of the American Medical Association*, 303(3), 288-288
3. CDC. Fatalities and injuries from falls among older adults---United States, 1993--2003 and 2001--2005. MMWR 2006;55:1222—4.
4. Davis, J. C., Robertson, M. C., Ashe, M. C., Liu-Ambrose, T., & Khan, K. M. (2010). International comparison of cost of falls in older adults living in the community: A systematic review. *Osteoporosis International*, 21(8), 1295–1306.
5. Shimada H, Obuchi S, Kamide N, Shiba Y, Okamoto M, Kakurai S. (2003) Relationship with Dynamic Balance Function During Standing and Walking. *American Journal of Physical Medicine and Rehabilitation,* 82:511-516.
6. Fung J & Perez C. (2011) Sensorimotor enhancement with a mixed reality system for balance and mobility rehabilitation. Conf Proc IEEE Eng Med & Biol Soc; 6753-6757.
7. Yang Y, Tsai M, Chuang T, Sung W, Wang R. (2008) Virtual reality-based training improves community ambulation in individuals with stroke: A randomized controlled trial. *Gait Posture*, 28: 201-206.
8. Gottshall K, Sessoms P, Bartlett J. (2012) Vestibular physical therapy intervention: utilizing a computer assisted rehabilitation environment in lieu of traditional physical therapy. Conf Proc IEEE Eng Med Biol Soc :6141-6144.
9. Horak F, Wrisley D, Frank J. (2009) The balance evaluation systems test (BESTest) to differentiate balance deficits. *PHYS THER*, 89(5):484-498.
10. Berg K, Wood-Dauphinée S, Williams J, Gayton D. (1989) Measuring balance in the elderly: Preliminary development of an instrument. *Physiotherapy Canada,* 41:304-311.

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TreadSense, the device used in this study and developed by the principal investigator, has a US patent pending.