

EFFECTS OF BLURRING VISION ON M/L BALANCE DURING STEPPING UP OR DOWN TO A NEW LEVEL IN THE ELDERLY

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BACKGROUND

Visual impairment has been found to be associated with an increased risk of falling in the elderly (e.g. Ivers et al. 1998, Jack et al. 1995). In the study by Jack et al. half of the elderly patients admitted to an acute geriatric clinic were reported to have impaired vision, with a high prevalence (76%) of visual impairment in patients admitted due to falls. Stair and kerb negotiation seems to be a particular problem for the elderly with falls on stairs being the leading cause of accidental death (Dowswell et al., 1999). It is widely accepted that the elderly have an increased susceptibility to falling due to age-related deterioration in postural control mechanisms, and it has been demonstrated that deficits in medio-lateral (ML) postural stability are able to distinguish fallers from non-fallers (Maki et al., 1994). It therefore seems pertinent to investigate how impaired vision in the elderly affects ML balance when negotiating stairs and/or steps.

The present study determined how ML balance parameters when stepping up or down to a new level were affected by blurring the vision of healthy elderly subjects.

METHODS.

Twelve elderly subjects (72.3 ± 4.2 yr) were analysed performing single steps up and single steps down to a new level (7.2cm, 14.4cm, 21.6cm) with vision optimally corrected or blurred by cataract simulation lenses. The order of

measurement was randomised, and each stepping trial was completed twice. Subjects started with each foot placed on a separate (AMTI OR6-7) force platform (stepping up) or on a step positioned on top of each of the force platforms (stepping down). A five-camera motion analysis system (Vicon 250, Oxford Metrics Ltd) was used to determine whole body CM displacements and these along with GRF and centre of pressure data (at 50Hz) were exported in ASCII format for further analysis. Force and centre of pressure data from each platform were combined to provide global centre of pressure coordinates (CP). Differences between the ML GRF impulse (~to ML CM momentum) developed by the intended swing limb during double support, ML dynamic stability (RMS fluctuation in ML position of CP during single support), lateral position of the CM relative to the supporting foot (average horizontal ML distance between the CM and CP during single support) and movement phase times under optimal and blurred visual conditions were analysed using a random effects model. The terms in the model were vision (normal, blurred), step height (high, medium, low), direction (up, down) and repetition (trial 1, trial 2). Significance of the two-level factors were determined by the 'Z'-statistic, while the significance of the three-level factor was tested using a likelihood ratio (Chi-squared) test after first dropping the factor from the model.

RESULTS AND DISCUSSION.

Duration of double and single support and the ML GRF impulse were significantly greater when vision was blurred ($p < 0.001$), while ML dynamic stability ($p < 0.001$) and the average CM-CP ML distance ($p = 0.04$) was significantly reduced. Interactions terms and the effect of repetition were not significant ($p \gg 0.05$). These findings suggest that with blur the visual system was unable to provide accurate exteroceptive information and the stepping movement thus became uncertain. This uncertainty may explain why duration of double support was found to significantly increase by 16.7%, because it is during this time that anticipatory postural adjustments initiate forward progression of the CM and a shift from bipedal to unilateral stance. The finding that *ML GRFi* also increased with blurred vision during this phase by about 11.4% indicates that subjects developed greater lateral impulse so their CM would be 'shifted' closer towards the stance limb during the subsequent single support phase (indeed CM-CP ML distance reduced with blur from 83 ± 23 to 78 ± 22 mm). The increase in single support time when vision was blurred suggests that subjects were more tentative placing their lead limb on the ground or step. These adaptations, which are in keeping with our earlier study (Buckley et al., In Press) suggesting that with blurred vision the elderly become more cautious and attempt to 'feel' their way to the ground with their lead limb when stepping down, may have all contributed to the substantial (~26%) reduction in ML dynamic stability during single support ($p < 0.001$). Such reductions are likely to be crucial because of the narrow base of support during this time. In addition, ML dynamic stability decreased with increasing step height and was worse when stepping down than when stepping up ($p < 0.001$). Alterations in swing limb kinematics with step height increases, e.g. greater toe clearance when stepping up (Heasley et al., In Press),

increased ankle plantar-flexion ('reaching') when stepping down (Buckley et al., In Press), may explain why ML dynamic stability decreased with increases in step height and this might explain why stair riser heights of greater than 18cm have been associated with increased incidence of stairwell falls (Templer et al., 1985). The greater ML instability when stepping down compared to when stepping up was most likely due to the fact that stepping down includes a period (during single support) when body weight is supported on just the ball of the foot. This finding could explain why the incidence of falling is higher during stair descent than ascent (Tinetti et al., 1988).

In conclusion, findings of the present study indicate that ML balance parameters during the single support of stepping up and down are affected by blurred vision. Correcting common visual problems such as uncorrected refractive errors and cataract may thus be an important intervention strategy in improving how the elderly negotiate stairs.

REFERENCES

- Buckley JG. et al. (In Press). *Gait Posture* <http://www.sciencedirect.com/science/journal/09666362>
- Dowswell T. et al. (1999) UK:Department Trade & Industry.
- Heasley K. et al. (In Press). *Invest Ophthalmol Vis Sci*.
- Ivers RQ. et al. (1999). *J Am Geriatr Soc* **46**; 58-64.
- Jack CIA. et al. (1995) *Gerontology* **41**; 280-5.
- Maki BE. et al. (1994). *J Gerontol* **49**; M72-84.
- Templer J. et al. (1985). *J Safety Res* **16**; 183-196.
- Tinetti ME. et al. (1988). *N Engl J Med* **319**; 1701-7.

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