STEPPING UP TO A NEW LEVEL. EFFECTS OF BLURRING VISION IN THE ELDERLY

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INTRODUCTION
Falls within the elderly population are a major cause of injury-related admissions to emergency departments worldwide. In the UK for example 57% of all injury-related admissions into hospital were attributed to falls during 1995/6 (Dowsell 1999). Studies have sought to determine the causes of such falls and have revealed that fall location is very significant, with stairs and steps being the most frequently cited areas in which falls occur (Startzell 2000).

Research groups striving to highlight universal factors to falls have commonly agreed that visual impairment is a critical factor in increased fall risk (Ivers 1998). The deterioration of vision with age is an inevitable process, which may or may not be coupled with additional pathological conditions, such as cataract, a common condition experienced in the elderly, which has also been linked to falls (McCarty 2002).

Although links have been made between increased falls and stairs/steps negotiation and between increased falls and visual impairment little has been done to determine what effects visual impairment has on step negotiation in the elderly. Therefore the aim of this study was to look at the effects of blurring vision, using cataract simulation, on the step negotiation strategy of healthy elderly, through analysis of whole body centre of mass (CM) dynamics and foot clearance parameters.

METHODS
Subjects were initially screened to ensure no history of falls, mobility impairment and or visual impairment. Twelve subjects, 7 male and 5 female, (mean age 72.3 ± 4.17 years), volunteered to participate in this study. A battery of visual tests were undertaken to assess the visual functions of binocular visual acuity (VA), using the ETDRS logMAR chart, and binocular contrast sensitivity (CS), using the Pelli-Robson chart. Measurements were then repeated with the presence of the cataract simulation lenses.

A five-camera 3-D motion analysis system (Vicon 250, Oxford Metric Ltd) was used to record (at 50Hz) each subject stepping up to a new level, (heights of 73mm and 146mm). Two force platforms (AMTI OR6-7-1000) were used to collect centre of pressure (CP) data under each foot at 100Hz.

Trials began with subjects standing stationary with feet positioned half their foot length away from the step edge. They were instructed to take a single step-up onto the new level and resume a stationary position on the top of the step. Trials were performed twice and repeated with the addition of the cataract simulation lenses.

Using the Plug-in Gait software (Vicon Oxford Metrics Systems Ltd), whole body CM was calculated, as was joint ankle angle of the swing limb. Global CP was achieved by combining centre of pressure data from each force platform. The minimum distances between the step edge
and the tip of the subject’s shoe in horizontal and vertical directions (toe clearance) were also exported for analysis in both horizontal and vertical directions. The stepping movement was divided into: anticipatory, initial swing, terminal swing and weight transfer.

Statistical analysis was performed using a random effects population averaged model (Stat Corp., College Station, USA)

RESULTS AND DISCUSSION

In the blurred condition subjects took 11% longer across all stepping phases (p<0.05), reduced the mediolateral (but not anterioposterior) displacement of their centre of pressure from 37.6% stance width to 28.3% during the anticipatory phase (p<0.01). Peak mediolateral divergence between the CM and CP also decreased whilst in the anticipatory phase by 9.8mm (p<0.01). Toe clearance was found to increase during the blurred trials in both horizontal (28%) and vertical (19%) directions (p<0.05).

Maximal CM-CP divergence has been said to denote positional instability (Zachazewski 1993). In the present study mediolateral CM-CP divergence during anticipatory phase decreased with blurred vision, and was a direct consequence of a decrease in mediolateral displacement of the CP with blur. This reduction in CP movement indicates that subjects were cautious with regard to mediolateral instability and thus ensured the horizontal position of their CM was close to the centre of the base of support. The increase in step duration with blur was found to be similar across all phases of the stepping task. Increases in phase duration can be attributed to the visual system requiring more time to extrapolate appropriate exteroceptive information about the step itself, (anticipatory phase), and exproprioceptive information regarding accurate foot placement, (terminal swing and weight transfer phases). Additionally, the increase in toe clearance would result in longer step execution duration, due to the greater distance travelled by the foot to produce the higher trajectory over the step edge. As there was no change in ankle angle the increase in both vertical and horizontal toe clearance was postulated to be a change in hip kinematics. Vertical toe clearance decreased upon repetition indicating a learning effect that may have been due to energy conservation.

SUMMARY

This study has highlighted that a two-fold safety driven adaptation occurs when under the influence of visual disturbance such as cataract. Firstly CM excursion within the base of support was reduced, to increase dynamic stability, and secondly toe clearance in both horizontal and vertical directions, was increased to reduce the risk of tripping by providing greater room for error. Since this study looked at the temporary effects of blurring vision future work is needed to compare the chronic effects of cataractous blur.

REFERENCES


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