reduced base) to reduced fear of falling, reduced frequency of falls, and larger sway while maintaining stability.

Fay B Horak, PhD, PT
Senior Scientist
RS Dow Neurological Sciences Institute
1120 NW 20th Ave
Portland, OR 97209-1595

References

Author Response

We thank Dr Horak, one of the world’s outstanding authorities on posture and movement, for providing such a thoughtful commentary. Given that one important outcome rendered by commentators and authors’ responses is to provoke dialogue and creative thinking among readers, this response is crafted with that perspective in mind.

Dr Horak is most accurate when she states that what we are describing is not postural stability, but rather postural sway. We, too, view sway as a component of posture. Sway can be measured as changes in center of pressure, center of mass, or a combination thereof, and, like kinematic and electromyographic measures, sway contributes to the total picture of biped (or quadruped) stance characteristics. Therefore, sway measures should not be construed as the sole or major component of postural stability.

Where we begin to differ slightly from Horak and Macpherson’s definition of postural stability is the inclusion of fall behaviors. Certainly, postural stability and control over the body’s center of mass are as vital to the older individual struggling for axial control in a seated reaching task as they are for an individual who has full upright weight-bearing capabilities. We prefer viewing postural stability as the development and execution of a controlled strategy that enables the individual to successfully maintain sitting, biped, and ultimately uniped positions while controlling the environment. We identify balance as the development and execution of a (successful) strategy that prevents a fall from occurring. Thus, balance is called into play during single-limb support or when biped sway becomes so large as to move both center of mass and center of pressure to the fringes of base of support. In such circumstances, the development of a stepping strategy as a protective postural response is mandatory.2 We believe that most falls, except those associated with orthostatic hypotension on rising from a sitting, supine, or reclined position, rarely occur during biped stance in natural, nonlaboratory environments. Most falls seem to occur as trips or slips, usually in single-limb support, that is, during a step.3

Certainly if sway is rapid or hip and knee movements are engaged, kinetics and kinematics come into play, and not just changes in center of mass; however, in our study sway was not rapid, and all subjects were instructed to stand as steady as possible (not sway). We did not observe large truncal or shoulder motions for any of our perturbations. Tai chi involves slow, rhythmic movements with progressively decreasing bases of support with precise truncal rotation.4 These elements as well as the specific tai chi exercise forms we used are described in detail.
Although none of our subjects were patients, Dr. Horak does identify patients, such as those with Parkinson's disease, as having poor stability and a greater tendency to fall even when body sway is minimal. Given our paradigm, we would hypothesize that training these patients to abort falls would require the use of adequate stepping strategies engaged through efforts to scale total sway excursions to the boundaries of the base of support, first in biped and ultimately in uniped fashion.

In our study, the tai chi participants reduced their fear of falling. The computerized balance training strategies did not contribute to a reduction in fear of falling nor did they augment this fear. In the Atlanta FICSIT (Frailty and Falls: Cooperative Studies on Intervention Techniques) trial, balance training did emphasize increased sway and center-of-mass displacement in a biped stance. The reality, however, is that controlled clinical studies have not demonstrated a reduction in fall behaviors or delays in fall occurrences among older individuals using balance machines. Current clinical balance training that emphasizes more pelvic and trunk rotation while manipulating visual representations of force from the platform coupled with push-wall exercises, turns during ambulation, heel-cord stretching, head rotation during ambulation, and rocking on compliant surfaces may improve such results. Therefore, cues that provide kinesthetic awareness and stress the vestibular system while providing feedback about changes in force characteristics during functional weight bearing may prove to be valuable in delaying or reversing fall behaviors.

We do not think that fear of falling could improve balance or degrade it. Rather, the reverse appears to be more appropriate. Fear can be overcome through changes in behaviors, including intrusiveness, confidence, and self-mastery. The factors contributing to these changes reside in the approach, in the strategy used, and in the clinician-client interface. With respect to the last factor, investigations examining the influence of the instructor, whether for tai chi, computerized balance, or more traditional approaches, warrant further exploration.

In summary, what we wish readers and clinicians to ponder is the perception that there is a difference between learning to enhance center-of-mass or center-of-pressure movement of the limits of stability and learning controlled motions as those limits are surpassed. Certainly, cautiously progressing any posturally based intervention toward the latter should engage uniped motions, especially because this position is experienced by most older individuals when encountering falls, whether the modus operandi is a trip or a slip. For individuals with vascular hypersensitivity to sudden postural changes or with defined vestibular disease, this approach might not be as beneficial. In the interim, it is wise to recognize that the ability to control center of pressure during quiet standing or the provision of random but moderate angular perturbations after usual machine-based postural training, without integrating this training into functional activities, is not necessarily associated with an improved fear of falling or a delayed onset of fall events in older, sedentary individuals.

Steven L. Wolf, PhD, PT, FAAPA
Huiyan X Barnhart, PhD
Gary L. Ellison
Carol E. Coogler, ScD, PT

References