

## **Postural Stability: Effect of Age**

**Dr Diganta Borah**, MBBS, MD, DNB, Senior Resident\*

**Dr U Singh**, MBBS, DPMR, DNB, Prof & Head\*

**Dr Sanjay Wadhwa**, MBBS, DPMR, DNB, Prof & Head\*\*

**Dr M Bhattacharjee**, MBBS, MD, Senior Research Associate#

\* Department of Physical Medicine and Rehabilitation, All India Institute of Medical Sciences, New Delhi

\*\*Department of Physical Medicine and Rehabilitation, PGIMER, Chandigarh

# Department of Physiology, All India Institute of Medical Sciences, New Delhi

### **Abstract**

**The number of elderly persons is increasing in our society as a result of increase in life expectancy. Falls in elderly population is a major cause of morbidity and mortality. Falls in such persons can occur without any evident disease or postural difficulty. Postural instability has been documented in such persons. This may be a reflection of normal aging process. This instability becomes more obvious in conditions demanding higher degree of postural adjustments. In challenging conditions this instability may result in falls with varying degree of consequences. Proper preventive strategies can help in minimizing such fall and its consequences.**

### **Introduction**

The ability to maintain balance in an erect posture over a relatively narrow base is a unique feature of humans. This feature plays an important role in our day to day activities. Therefore abnormality in postural stability may lead to serious consequences adversely affecting the normal life. The functionally important components of balance are maintenance of posture, postural adjustments in anticipation of and during a self initiated movement and adjustments in response to an external perturbation.<sup>1</sup>

Balance emerges from a complex interaction between sensory and musculoskeletal systems, integrated and modified within the central nervous system in response to changing internal and external conditions.<sup>1</sup> The sensory systems involved in the maintenance of balance include vestibular, proprioceptive and visual systems.<sup>2</sup> The information provided by these sensory system are relayed to the central nervous system where they are analysed and processed into an appropriate response. The information from the central nervous system is carried down to the musculo-skeletal system to bring about movement of different body segments so that the centre of gravity remains within the stability range and thereby maintain erect posture. In addition to various disease conditions, aging can disturb the equilibrium of this close interaction of various systems to maintain balance adequately.

Increased life expectancy is a blessing of modern medicine. As a result we have a large number of elderly persons in our society. Therefore it becomes necessary to maintain quality of life of elderly people. This can be achieved partly by protecting them from preventable bodily damages. Falls are an example of such preventable accident which can cause variable degree of bodily damage. Falls in elderly people may occur because of postural imbalance which may not be evident in normal circumstances. Implementation of proper preventive measures can minimize such falls and their consequences in elderly persons.

### **Age and Postural Stability**

Postural instability is a common problem in elderly population. There may be numerous causes for age related postural disturbances. With increasing age there is increased probability of the elderly individuals for developing specific pathologies, which lead to accelerated degeneration in neural and/or musculoskeletal systems.<sup>3</sup> Standing balance appears to be influenced by age.<sup>4</sup> Progressive functionally evident, age related quantitative balance changes occur independent of typical geriatric pathological changes.<sup>5</sup> A relatively inactive lifestyle may also result in disuse changes in neuromuscular system, including muscle weakness and slowed response time. A combination of reduced sensation, leg muscle weakness and increased reaction time appear important factors associated with postural instability in elderly.<sup>6</sup> This instability in posture may result in falls. Age related

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*Address for correspondence: Dr Diganta Borah, Department of PMR, AIIMS, New Delhi 110029*

deterioration in sensory motor function of muscles may contribute to the increased fear and frequency of falls in elderly subjects, thereby decreasing independence.<sup>7</sup> Falls in elderly is a major cause of morbidity and mortality.<sup>8</sup> Many risk factors have been associated with falls among elderly persons, including muscle weakness, use of certain medications, cognitive impairments, depression and a history of previous falls.<sup>9,10,11</sup>

Attempts have been made to see the effect of age on postural stability in various conditions. Many authors attributed falls in elderly to impaired balance. Most of the accidental falls in elderly are due to impaired balance.<sup>12</sup> They face difficulty to correct their balance once they have stumbled.<sup>12</sup> Tripping is also a common cause of falls in elderly<sup>13</sup> which may be attributed to change in gait with age in terms of height of lifting the feet. Other gait parameters such as stride length, walking velocity and gait quality are also found to be deteriorated in elderly subjects with history of falls.<sup>14,15</sup>

Postural instability increases with increasing age and is more evident in males than females.<sup>16</sup> The ratio of the area of motion of the centre of pressure to the area within the stability boundary increased with age and the time to contact with postural stability boundary decreased with age. These reduced margins of dynamic stability may be a factor contributing to the progressive instability of posture in elderly.<sup>17</sup> Moreover the flexibility of the ankle-hip-head axis decreases with age resulting in more rigid stance in elderly persons.<sup>18</sup>

Functional base of support (FBOS) is the anterior posterior distance between the mean centre of pressure positions during first and last 5 seconds of a 20 seconds trial divided by foot length. FBOS may decrease with age without any evident disease which can affect balance.<sup>19</sup> The elderly subjects exhibit more postural sway during quiet standing.<sup>20,21</sup>

The reduced margins of dynamic stability, decreased flexibility and FOBS, increased postural sway all increase the instability in posture thereby increase risk of fall in elderly persons.

Integrity of sensory inputs is an important component in maintenance of balance. Deficit in one sensory input is usually compensated by other inputs. But With increase of age there is a decrease in ability to balance under conditions of reduced or conflicting sensory information.<sup>22</sup> In elderly fallers balance performance significantly declines when one sensory input is compromised.<sup>23</sup> Difficulty in maintenance of balance in elderly becomes obvious under conditions of deprived vision.<sup>24</sup> Visual functions such as visual acuity, visual perceptual errors of verticality and horizontality, contrast sensitivity and stereopsis have close association with balance performance in elderly.<sup>25,26,27,28</sup> Alteration of

proprioception results in difficulty in balance in elderly persons.<sup>28,29</sup> Thus in challenging conditions maintenance of balance becomes more difficult in such persons.

Postural sway increases with age.<sup>20,21</sup> This becomes more evident with alteration to visual and peripheral sensation and especially when both are altered concurrently.<sup>6</sup> In addition elderly persons are slower at detecting postural disturbances,<sup>20</sup> which results in increased reaction time.<sup>6</sup> Moreover the frequency and pattern of compensatory stepping reaction in response to unpredictable perturbation is different in healthy and active elderly persons from that in adults.<sup>30</sup>

Muscle strength is also an important factor in balance performance. Weakness in leg muscle has been found to be associated with postural instability in elderly.<sup>6</sup> In elderly persons weaker muscles impose a relatively higher demand during muscular activity leading to early fatigue and postural imbalance.<sup>31</sup> The muscle strength in the hip, knee and ankle joints is closely associated with loss of balance during challenging balance tests in older persons.<sup>32</sup> Weakness in the muscles around the ankle joint resulting in inability to generate necessary movement to maintain balance may be a cause of dominance of hip sway strategy in elderly persons.<sup>29</sup> The relationship between muscle strength and balance might be in part due to a direct relationship between muscle power and balances and might be in part due to physical activity which can both maintain muscle power and stimulate balance responses.

After steady period in mid-adulthood the muscle strength start declining at around 5<sup>th</sup> decade of life. The maximum speed of movement also follows the same pattern of change with age. Furthermore type II muscle fibre shows significant atrophy with increasing age.<sup>33</sup> The proximal muscles of the lower limb have been reported to be especially affected by muscle fibre atrophy and decline in maximum strength during aging.<sup>34</sup>

Quadriceps strength is one of the most important factor for dynamic stability during gait and elderly persons with greater quadriceps strength shows shorter double limb support time than weaker individuals<sup>35</sup> indicating a better balance in persons with strong quadriceps.

Effect of aging can also be seen in peripheral and central nerve conduction. The changes that are found with aging are slowed peripheral nerve conduction velocity, increased F-wave onset latencies in limbs, increased somatosensory evoked potential latencies and decreased spinal sensory conduction velocity.<sup>36</sup> This decreased nervous conductivity may be a cause of increased reaction time in elderly persons.

The alertness, a precursor to attention, among older adults is a significant predictor of postural control when

vision is intact.<sup>37</sup> Balance performance declines more in elderly subjects if engaged with additional cognitive demands.<sup>38,39</sup> Even during quiet stance simultaneous performance of a cognitive task results in an increased postural sway which is more pronounced in elderly.<sup>40</sup> As the sensory information decreases, the postural task becomes increasingly difficult for older subjects and requires more of their attention capacity.<sup>41</sup> The ability to maintain a stable posture following an external perturbation is more attentionally demanding for older adults than for younger adults suggesting an increased risk for loss of balance and falls in some older adults if sufficient attentional resources is not allocated to the task of postural recovery.<sup>42</sup> Therefore postural stability in older adults may be improved and falls reduced, through interventions, which enhance the alertness and attention among older subjects.<sup>37</sup>

### Our experience

We conducted a study to see the changes in balance performance with increasing age. The elderly persons enrolled in our study were healthy, without any obvious postural instability and without history of fall. We found an increase in postural sway which became more evident in conditions of conflicting sensory input. They were using predominantly hip sway strategy for maintenance of balance. Although the control of direction was maintained their velocity of movement was reduced and the reaction time was increased.

Overall balance performance started declining after 5<sup>th</sup> decade of life indicating deterioration of postural stability with age.

### Conclusions

Old age is an important and integral part of ones life. It should be as enjoyable as previous days of life. Prevention of bodily damage is one of the important measures to achieve this goal. Fall, a major cause of such damage can occur without any evident balance problem. In such persons impairment of balance may be revealed by proper balance assessment. Many authors suggested this as a part of normal aging process. Although, it may not manifest during day to day activities, this instability may have adverse consequences in certain conditions which demand high degree of postural adjustments.

Therefore education/ advice of elderly population regarding sensory consciousness, alertness, regular physical activity and provision of proper environment should be implemented which may be of great value in decreasing at least to some extent the falls and its consequences in elderly population.

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