Role of Ankle and Subtalar Joint Mobility in Functional Reach in Females

Majumi Mohamad Noohu*; Leena Dhawan**

Abstract

Objective: To find out the correlation between ankle mobility and functional reach value in females.

Methods: Range of motion of ankle and subtalar joint were measured in young and elderly females and functional reach was measured and they were compared between the groups and a correlation analysis was done to find out the relationship between ankle mobility and functional reach value.

Results: There is a positive correlation between ankle dorsiflexion (active and passive) and functional reach in females.

Conclusion: There is a significant reduction in ankle mobility, functional reach value in elderly females as compared to young adults and a positive correlation between the ankle range of motion and functional reach in both the groups.

Key Words: Postural control, functional reach, joint mobility and falls.

Introduction

Balance is the ability to maintain equilibrium by positioning the centre of gravity over the base of support. Postural control plays a vital role in maintaining equilibrium. It is carried out by a complex process involving affere nts from sensory system, integration of affere nts by central nervous system and affere nts being sent from central nervous system to an intact musculoskeletal system.¹ The systems model of motor control developed by Bernstein has lead to new insights into the control of movement and posture.² According to systems theory, every system in the human body contributes to postural control. The nervous system is only a subsystem of a complex flexible system. This was a major shift from the traditional view of reflex-hierarchical theory, in which postural control was totally attributed to nervous system control.² Studies have proven, vision, somatosensory inputs, vestibular inputs, mental status and musculoskeletal system plays a great role in maintenance of balance. Evaluation of balance, particularly standard balance is a major part of routine neurological or medical assessment. It helps to understand how the postural control system works, aids in clinical diagnosis, for assessment of treatment efficacy and used to identify elderly people who are prone for falls. Functional reach is a dynamic balance test developed to assess dynamic balance in elderly by Duncan et al in 1990.³ Functional reach has proven its test, retest reliability and inter observer reliability. The functional reach is a simple and effective clinical measure that can predict falls in elderly.⁴

The problems of elderly are largely of women, may be due to the fact that they live longer than men. Despite many changes for younger generation of women, the elderly female are still bound by society to their traditional home making roles.⁵,⁶ Health care measures for women should be given due concern in the society. Females swayed more and lost their balance more often than men when the surface was challenged.⁷,⁸ There are inevitable changes in musculoskeletal system due to normal ageing process. Ageing will lead to reduction of muscle strength, reduced joint mobility and degradation of incoming sensory information which in turn may contribute to risk for falls in elderly.⁹ Vander-voort suggested that reduced range of motion at the ankle joint may be a risk factor for tripping and falling.¹⁰

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This study was carried out to find the role of ankle and subtalar joint mobility in balance performance in female population, with emphasis on elderly females. From this we can target special groups and develop effective physiotherapy measures to tackle the problem of the elderly female population.

Material and Methods

The study was approved by research and ethics committee of Department of Rehabilitation Sciences, Jamia Hamdard, New Delhi. A sample of convenience of 70 healthy females of age group between 20 to 80 years was included in the study. They were grouped into young adults (Group A- 20 to 30 years) and elderly adults (Group B- 60 to 80 years). Subjects were recruited from Jamia Hamdard University for group A and for group B, subjects were from Jonty village, New Delhi. The subjects were briefed about the procedures and informed consent was signed. Subjects with any active illness, spinal deformity, neurological disorders and recent injury to the ankle joint were excluded from the study.

The study was of a correlational design. A yardstick to measure the functional reach and a goniometer to measure the range of motion were the materials used in the study. Subjects were measured for active and passive range of motion for ankle joint (dorsiflexion and plantar flexion) and passive range of motion for subtalar joint (inversion and eversion- calcaneal component) in prone position with knee extended with help of goniometer.11,12 For measuring functional reach, subjects were positioned in standing, adjacent to the wall mounted with yard stick and arm closer to the yard stick was flexed forward to 90°, parallel to the yard stick. The measurement in the yardstick which corresponded to the third metacarpal was marked. This was taken as the initial reach. Then the subject was asked to move forward as far as possible without taking a step. The position of the 3rd metacarpal was noted and taken as the final reach. The difference between these two values gave the functional reach value. No attempt was made to control the subject's method of forward reach, but if the subject touched the wall or took a step during the procedure, the attempt was considered invalid and repeated. The same procedure was repeated thrice and the average was taken, all the subjects were guarded during testing by an assistant.3

The data procured was analyzed using STATA 7.0 software and statistical test used was two sample t-tests for finding the difference between age, ankle and subtalar joint range of motion and functional reach between two groups. Analysis of co-variance was used to find out the correlation between functional reach value and ankle and subtalar joint range of motion in the subjects. A significance level of p≤0.05 was fixed.

Results

The mean ± SD of age for Group A was 22 ± 2.01 and for group B was 64.64 ± 3.05. The difference between the groups were significant. All the range of motion values measured also showed a significant difference between the groups. Ankle dorsiflexion (active and passive), plantarflexion (active and passive), inversion and eversion (passive calcaneal component) were compared (Table 1). The mobility of ankle and subtalar joint was reduced in group A as compared to group B. The functional reach value showed a positive correlation between the dorsiflexion values and not with any other range of motion values (Table 2).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group A (Mean ± S.D.)</th>
<th>Group B (Mean ± S.D.)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>22 ± 2.01</td>
<td>64.64±3.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Active dorsiflexion (degrees)</td>
<td>16.94 ± 1.0</td>
<td>13.41+0.99</td>
<td>0.01</td>
</tr>
<tr>
<td>Passive dorsiflexion (degrees)</td>
<td>18.7±1.05</td>
<td>15.32+0.984</td>
<td>0.02</td>
</tr>
<tr>
<td>Active plantar-flexion (degrees)</td>
<td>37.02+1.1</td>
<td>33.7±1.65</td>
<td>0.01</td>
</tr>
<tr>
<td>Passive plantar-flexion (degrees)</td>
<td>38.83±1</td>
<td>35.38±1.43</td>
<td>0.01</td>
</tr>
<tr>
<td>Passive inversion (calcaneal component) (degrees)</td>
<td>9.1±1.94</td>
<td>7.55±0.92</td>
<td>0.01</td>
</tr>
<tr>
<td>Passive inversion (calcaneal component) (degrees)</td>
<td>17.42±0.95</td>
<td>3.75±1.20</td>
<td>0.01</td>
</tr>
<tr>
<td>Functional reach value (cm)</td>
<td>34.14+1.95</td>
<td>27.6±1.00</td>
<td>0.01</td>
</tr>
</tbody>
</table>

p ≤ 0.05, significant difference.

Discussion

The result showed a statistically significant reduction of functional reach values in women with increasing age and is in agreement with earlier study.3 The reduction of joint range of motion studied also agrees with findings of Vandervoort.13 Normal ageing and immobilized muscles showed similar changes, such as the reduced cross sectional
area of a muscle, reduce strength, histochemical changes such as reduction of water content and reduction of hyaluronic acid. So all these changes in musculoskeletal system may be the contributing factors in reduced ankle mobility in elderly females. The previous studies also reported reduced torque production of ankle musculature across the age and joint range of motion in lower limb is also reported to be reduced in elderly.  

The plantar flexion power during the late stance phase of gait appeared to be reduced and it is suggested that plantar flexion training may be required.  

Table 2. Correlation of functional reach values with range of motion.  

<table>
<thead>
<tr>
<th>Group</th>
<th>Range of Motion</th>
<th>Functional reach (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active dorsiflexion (degrees)</td>
<td>0.747</td>
</tr>
<tr>
<td></td>
<td>Passive dorsiflexion (degrees)</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>Active plantarflexion (degrees)</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>Passive plantarflexion (degrees)</td>
<td>-0.0005</td>
</tr>
<tr>
<td>Group A</td>
<td>Passive eversion (calcaneal component) (degrees)</td>
<td>0.0620</td>
</tr>
<tr>
<td></td>
<td>Passive inversion (calcaneal component) (degrees)</td>
<td>0.195</td>
</tr>
<tr>
<td></td>
<td>Passive dorsiflexion (degrees)</td>
<td>0.598</td>
</tr>
<tr>
<td>Group B</td>
<td>Active plantarflexion (degrees)</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Passive plantarflexion (degrees)</td>
<td>0.1532</td>
</tr>
<tr>
<td></td>
<td>Passive eversion (calcaneal component) (degrees)</td>
<td>0.1532</td>
</tr>
<tr>
<td></td>
<td>Passive inversion (calcaneal component) (degrees)</td>
<td>0.1952</td>
</tr>
</tbody>
</table>

r, correlation coefficient.  

The analysis of co-variance showed a positive correlation of functional reach with passive and active dorsiflexion but plantarflexion and subtalar joint range of motion do not reveal a correlation. This implies that women with more joint dorsiflexion had more functional reach value. According to single link model, ankle joint is considered to be an important element in postural control mechanism. It is believed that the subtalar and ankle joint are independent but both act as a single unit during walking. An ankle strategy, hip strategy or stepping strategy is used as a motor response strategy when balance is challenged. In an experimental study, subjects were perturbed while standing on supporting surface of different base of width. When the perturbations were given the muscles around the ankle joint were activated. The sequencing was such that it was from distal to proximal, calf, thigh to trunk. This resolved the centre of mass forward or backward. The movement primarily takes place around the ankle joint. Young adults used more of ankle strategy, where as the elderly used more of hip or stepping strategy to regain balance. This pattern is called ankle strategy. So this indicates the importance of ankle mobility in postural control mechanism. More detailed kinematic study is to be done to find out how the elderly and younger people differ in a forward reaching task.  

Conclusion  

There is a significant reduction in ankle mobility and functional reach value in females across the age and a positive correlation between the ankle range of motion and functional reach in both groups. The findings of reduced range of motion in the ankle and subtalar joint and reduced functional reach value in elderly females leads to the point that they need regular exercises program, in addition they may participate in some sort of balance training.  

References  


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