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The comparison of spinal curves and hip and ankle range of motions between old and young persons

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Abstract

Background: Falls have been strongly associated with decreased physical activity and impaired mobility. Reduced range of motion, as a consequence of muscle stiffness, has been indicated to assume a positive relationship to fall incidence. Also clinical observations suggest that maintaining the normal spinal curves is associated with the prevention of spinal, knee and hip disorders. Thus, the aim of this study was to compare hip and ankle range of motions and thoracic and lumbar curves between young and old persons

Methods: Using a nonprobability sampling 30 elderly persons at average of 68.14 ±4.03 years of age and 30 young people (age 23.37 ± 2.31 years) through a case – control design participated in the study. Maximal hip extension and ankle dorsiflexion range of motions were measured by a standard goniometer. Thoracic and lumbar curvatures were measured by a flexible ruler in both groups. Independent t test were used to statistically analyze differences between groups.

Results: Compared with the young group, the elderly group had decreased hip extension and ankle dorsiflexion motions ($p<0.01$). The result of independent t test showed that the mean of lumbar curve was higher in young group (31.29± 6.37) than elderly subjects (27.93±8.11) ,however, no significant difference was found between two groups ($p=0.08$). The result also showed increasing thoracic curvature with aging (young group=34.43±13.27, old group= 36.19±8.97), however, no significant difference was found between two groups ($p=0.55$).

Conclusion: Findings suggest decreased ankle and hip joint range of motions should be considered in rehabilitation of elderly people.

Keywords: Elderly, Muscle length, Rehabilitation, Spinal curves.

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Introduction

Many investigators have found an association between spinal alignment and low back pain. Low back pain and hip and knee joints pain are major concerns in the elderly, whose population is increasing (1-3). Some clinical studies have found an alteration in spinal curves with increasing age. Altered spinal curves may cause disk degeneration, radicular pain and vertebral fractures in the elderly (4,5). Sagittal spinal curvatures act as a shock absorber. A flattened spine exerts one-fifth the structural strength compared to a spine with thoracolumbar curves (4). In addition, spinal mobility was proven as an important factor relating quality of life (6,7). Moreover, studies have shown hyperkyphosis is associated with decreased mobility, poor balance and greater body sway, which in turn is correlated with increased risk of falls, vertebral fractures, chronic back pain and

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functional decline (5,7).

Reduced range of motion, as a natural consequence of the muscle-tendon unit and surrounding connective tissue stiffness with aging has been considered as a major cause of falls. Some studies have indicated that reduced range of motion, especially in hip and ankle joints may increase the risk of falls (8,9). Gait studies of healthy elderly have shown decreased walking speed, less range of motion of the hip, knee, and ankle joints, and increased anterior pelvis tilt (9,10).

Muscle –tendon tightness that associated with aging process especially affect the bi-articular muscles. Kerrigan et al (8) showed that elderly fallers are characterized by marked hip tightness. They also reported an increase in peak hip extension as a result of 10 week stretching exercises (11). In addition, studies with older persons have shown an association between improved flexibility and increases in activities of daily living and quality of life (6, 7, 11, 12)

It seems that contractures of bi-articular muscles of hip, knee and ankle hip flexion contractures to occur with reduced of physical activity in elderly(8). Also, the standing posture depends not only on spinal alignment but also on hip, knee and ankle joints alignments (1,3). Therefore, it is important to explore this issue in the Iranian elderly. The present study aimed to compare the thoracic and lumbar curves and hip extension and ankle dorsiflexion range of motions between old and young persons

Methods

30 healthy old persons over 60 years old (age range, 63-78 yrs, 16 female, 14 male) were recruited to participate in this study. The participants had been living in the facility care unit and were medically stable with no evidence of vestibular or neuromuscular conditions. All the subjects were independent in daily living activities no walking aids. The control group (young group, n=30) with an average age of 23.37 ± 2.31 years was height, weight and sex matched, with same exclusion criteria. Before participating in the study, all subjects signed an informed consent form approved by the human subjects committee of University of Social Welfare & Rehabilitation Sciences.

Test procedures

A standard goniometer was used for measuring passive range of motion of hip and ankle joints. Each measurement was repeated twice to allow evaluation of intratester reliability. The right and left lower extremities were assessed for each participant .The mean of the two measurements was considered as the joint motion value. For the measurement of passive hip extension the subject lies prone. Relaxed hip extension angle was measured using a goniometer and defined as the angle between the horizontal and a line from the greater trochanter to the lateral femoral condyle (8). Length of plantar flexors was determined by measuring the amount of ankle joint dorsiflexion with the knee extended. The subject was positioned in the prone position with the foot hanging off the table and the subtalar joint maintained in the neutral position. Dorsiflexion was measured with a standard goniometer as the angle formed by the lateral midline of the leg on a line from the head of the fibula to the tip of the lateral malleolus and the lateral midline of the foot in line with the border of calcaneus (13). The average measurement of two trials with 5-second pause between trials was recorded.

Subject's spinal curves were assessed using flexible ruler and the measurement performed with the subject standing in relaxed posture. For the measurement of spinal curves, the flexible ruler is placed between two marked points (T1, T12) vertebrae for measurement of kyphosis and T12, S2 vertebrae for measurement of lordosis) and shaped as spinal curves. The flexible ruler was removed and placed on a piece of white paper so the spinal curves could be copied by a pencil along the flexible ruler. A vertical line was drawn to connect the T1 to T12 and T12 to S2 landmarks (total

Table1. Intraclass correlation coefficient (ICC) and standard error of measurement (SEM) values for intratester reliability. (N=10 subjects)

Variables	ICC	SEM
Lumbar curve	0.92	0.87
Thoracic curve	0.90	0.82
Hip extension range	0.93	1.10
Ankle dorsiflexion range	0.97	1.56

length of curve/L line) and the maximal width of spinal curvature measured in centimeter (H line). Then using the equation Ɵ=4× [arc tang (2H/L)] the degree of spinal curves were calculated (14).

The data was analyzed using the SPSS statistical software version 19. Means and standard deviation were calculated. The intra-class correlation coefficient (ICC), two way mixed effect model, and standard error of measurement (SEM values) were used to assess intra-tester reliability of the measurement. We calculated the ICC (3, 1) as described by Shrout and Fleiss (15), because only one judge evaluated the same population of subjects.

Independent t tests were performed to compare hip extension and ankle dorsiflexion range of motions and thoracic and lumbar curves between the young and elderly persons.

Results

Table 1 presents the ICC and SEM values for test- retest reliability of the each measurement taken in the pilot study. ICC values for the all measurements were greater than 0.90.

Descriptive statistics for the measurement scores in two groups presented in Table 2.

The result of independent t test showed that the mean of lumbar curve was higher in young group (31.29 ± 6.37) than elderly ones (27.93 ±8.11), however, no significant difference was found between two groups (p= 0.08) (Table 2). The result also showed increased thoracic curvature with aging process (young group= 34.43 ± 13.27, old group= 36.19 ± 8.97), however, no significant difference was found between two groups (p= 0.55).

The result of independent t test also showed that young person's demonstrated a significantly higher hip extension (hip flexors length) with ankle dorsiflexion (plantar flexors length) range of motions than elderly group (p<0.01) (Table 2).

Discussion

Due to increasing elderly population is worldwide, concern over health problems and medical and social costs of the elderly are growing. The data from this study demonstrated that reduced hip extension and ankle dorsiflexion occur in elderly (p<0.01). In agreement with previous studies (8,10,11,16) the present study showed that reduced hip extensors or hip flexion contractures occur in Iranian elderly. There is a tendency with age to develop contractures of the hips, because the hip joint is less often fully stretched due to reduction in physical activity (10). On the other hand, the only regular daily activity that extends the hip to its maximum and thereby stretching the hip flexors are walking and running

Table2. Results of independent t test comparing of hip extension and ankle dorsiflexion (plantar flexors length) ranges and spinal curves between the young and old groups

Variables (measurement unit)	Group (Mean±SD)		Mean differences	p
	young	old		
Lumbar curve (degree)	31.29±6.37	27.93±8.11	3.36	0.08
Thoracic curve (degree)	34.43±13.27	36.19±8.97	1.76	0.55
Right Hip extension range (degree)	24±4.70	13.6±5.99	3.40	p<0.001
Left Hip extension range (degree)	16.37±3.08	8.72±4.56	9.97	p<0.001
Right Ankle dorsiflexion range (degree)	17.230±3.19	6.57±8.30	10.66	p<0.001
Left Ankle dorsiflexion range (degree)	16.83±3.10	6.86±8.40	10.94	p<0.001

(10, 15). Thus a decline in these activities along with aging will contribute to hip flexors tightness and contracture (10). It also suggested that hip flexion contractures or reduced hip extension may lead to an increase in anterior pelvic tilt and decrease in stride length and walking speed in elderly people (8,11). A reduction in hip extension range and stride length may be particularly important in situations requiring rapid changes in stride length such as, attempting to change walking speeds rapidly, or when faced with uneven surfaces or obstacles (8,16).

The sagittal motion around the hip joint is achieved by the hip joint itself and by the support of the lumbar spine (17). In our measurement of lumbar lordosis, the mean angle in the old and young group were 27.93±8.11 and 31.29±6.37respectively and the thoracic mean angle in the old and young group 36.19±8.97 and 34.43±13.27, respectively, however these differences were not significant.

Some studies showed that degenerative changes of the lumbar spine in middle-aged and elderly people can lead to decrease in lumbar lordosis and thoracic kyphosis (1-3 ,18). Berlemann et al (19) and Tsuji et al (2) demonstrated that in elderly people, decreasing lumbar lordosis lead to increasing thigh muscle function and knee flexion while standing .Offierski and Macnab(3) and Tsuji et al (2) reported a correlation between spine and hip joint pain and lumbar kyphosis and knee flexion position, respectively. They reported that concurrent diseases at hip-spine and knee-spine are common clinical problems in elderly (2, 3). It also suggested that kyphotic condition alters balance and increases the incidence of falling (17,20). The flattening of the lumbar spine thrusts the old person forward. It increases the load at anterior part of vertebral body and increases fall risk (4).

Our finding also showed that old people have decreased length of the calf muscles (ankle dorsiflexion range) than young people. According to previous studies, the old people had changes in the ankle joint capsule, associated ligaments fascia, the skin and decreased calf muscles length (21,22). Aging is known to bring about a loss of functional motor units, a decrease in the number and the size of both muscle fibers (type I, II), with the possibility of selective atrophy of type II fibers. The reduction in the number of functional motor units and muscle fibers may account for the decreased muscle mass, strength and extensibility observed for the older people (21). Gajdosik also showed that the older women had decreased maximal isometric strength of the calf muscles (21). Changing calf muscle function due to decreased length and strength may have some impact on ambulation and static and dynamic standing balance that warrant further investigation (21, 22).

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