한국전문물리치료학회지 제7권 제4호
KAUT PT Vol. 7 No. 4 2000.

Comparison of Spine and Lower Extremities Range of Motion Between in Elderly Fallers and Nonfallers

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국문요약

넘어지는 노인과 안 넘어지는 노인의 척추와 하지의 관절가동범위의 비교

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이 연구의 목적은 노인들 중, 넘어지는 사람들(fallers)과 안 넘어지는 사람들(nonfallers)의 경부, 체간, 하지의 관절가동범위를 측정하여 비교하는 것이다. 본 연구 대상은 남자 6명, 여자 22명, 나이 65세에서 88세의 노인으로 독립적으로 활동할 수 있는 사람들을 두 개의 집단으로 한 사람씩 면접을 통해 분류하였다. 대상자 선정 이전 일년 동안 한번 이상 넘어진 경험이 있는 사람들을 넘어진 사람들로 규정, 그리고 넘어진 경험이 없는 사람들을 안 넘어진 사람들로 정의하였다. 관절가동범위는 각도기로 측정하였고 미국 정형외과 학회(American Academy of Orthopaedic Surgeons)의 표준화된 가동 범위 측정방법을 사용하였다. 넘어진 사람들과 안 넘어진 사람들의 연구 결과의 차이를 알아보기 위하여 양측 독립성 t-검정을 사용했다. 연구결과, 넘어진 사람들과 안 넘어진 사람들간의 관절가동범위 중 흉요부의 굴곡, 신전, 우측굴곡, 좌측굴곡, 그리고 우측회전과 좌측회전, 고관절부의 신전, 내전, 외측회전과 내측회전, 그리고 족관절의 배굴에서 유의한 차이가 있었다. 이와 같은 결과는 체간, 고관절부 그리고 발목의 유연성이 노인들의 균형을 유지하는데 영향을 준다고 말할 수 있다.

핵심단어: 노인; 균형; 관절가동범위.

Introduction

Falls in elderly extends far beyond minor injury to significant loss of functional independence and even death (Chandler and Duncun, 1993). Falling accounts for the majority of deaths related to injury, the sixth leading cause of death among the elderly. An estimated 30 percent to 50 percent of adult, 65 years of age and older and 40 percent of adults over the age of 80 experience one or more falls annually (Lord et al, 1991). The fall causes the admission to a nursing home for people who are 65 years old are about 45 percent for women and 28 percent for men

(Mathias et al, 1988; Tinetti et al, 1988; Tinetti and Williams, 1997; Whitney et al, 1998).

A fall event occurs when the postural control system fails to maintain equilibrium. To achieve and maintain equilibrium, an individual must control and regulate specific postural output during voluntary, involuntary, or externally imposed movements of the center of gravity (O'Brien et al, 1997). Postural responses are executed through the musculoskeletal system and changes to any part of the musculoskeletal system may lead to increased difficulty in maintaining equilibrium (O'Brien et al, 1997). Adequate postural control requires keeping the center of gravity over the base of support during static and dynamic situations. The components of the postural control system are strength, range of motion, proprioception and central processing (Chandler and Duncun, 1993).

The fall in elderly is related to physiologic and biomechanic changes that are associated with aging. The potential ranges of joint motion vary throughout the life span because of age related changes in the mechanical properties and morphology of joint structures (James and Parker, 1989). Decrease in range of motion is associated with normal aging in both men and women. This decrease in joint movement exists even in the absence of pathology (Gajdosik et al, 1999). Loss of spinal and peripheral joint range of motion is associated with decreased postural control (O'Brien et al, 1997). Flexibility in joint movement is required for a person to accommodate various perturbations by allowing body to perform various postural control strategies.

There are no comprehensive analysis of joint range of motion other than lower extremities seem readily available and even then many of these previous studies only have examined the range of motion in anterior and posterior direction. For example, knee flexion and extension, ankle dorsiflexion and plantarflexion, and so forth. In normal adults, the anteroposterior and lateral stability is required to maintain balance. The objective of the present study is to determine and compare the difference of cervical, trunk and lower extremity range of motion in three dimensional directions between fallers and nonfallers. Physical therapists are involved in fall prevention and post fall rehabilitation in elderly population. Comparison of these data may be useful in understanding the joint flexibility differences between two groups and the relationship of joint flexibility at each joint to falls in elderly. This study may provide direction for intervention and area of range of motion assessment in elderly.

Methods

Procedure

Six males and 22 females, aged 65 to 88 years, independently residing in social service facilities and in the community, were classified into two groups as fallers or nonfallers. Fallers group consisted of 14 females with mean age of 77 and nonfallers group consisted of 6 males and 8 females with mean age of 73. The permission to participate in the study was obtained from each subject. In this study, a fall was defined as an event during which a subject comes to rest on the ground or at some low level, not as the result of major intrinsic event or overwhelming hazard (Lee and Kerrigan, 1991; Lord et al, 1992; O'Brien et al, 1997). The classification of two groups was made through interview process. A subject who reported history of one or more falls during one year period prior to date of recruitment was classified as fallers. A subject who denied any history of fall during same period was classified as nonfallers. All subjects were free from using assistive devices for ambulation and exhibited no pathology of central and peripheral nervous system, active orthopedic problems, and uncontrolled cardiovascular problems.

A goniometric measurement was used to determine joint range of motion. Measurements were taken at cervical and thoracolumbar spine, hip, knee, and ankle joints. The range of motion variables measured at cervical and thoracolumbar spine were flexion, extension, side bending right and left, and rotation right and left. The range of motion variables measured at hip joint were flexion, extension, adduction, abduction, and internal and external rotation. The range of motion variable measured at knee joint were flexion and extension. The range of motion variable measured at ankle were dorsiflexion, plantarflexion, inversion, and eversion. The reliability of goniometer for measuring lower extremity joint range of motion has been well documented (Boone et al, 1978; Smith and Walker, 1983; Walker et al, 1984). The range of motion was determined using standard for joint range of motion established by the American Academy of Orthopaedics Surgeons (Norkin and White, 1985).

Data Analysis

The mean values for all range of motion measured at cervical, thoracolumbar, hip, knee, and ankle joints were obtained and compared between fallers and nonfallers. The average of bilateral lower extremities range of motion were used to calculate the mean values for lower extremity. Two tailed student t-tests were performed using Microsoft Excel program to determine differences between in joint range of motion variables the fallers and nonfallers. The criterion used for statistical significance was α=.05.

Results

The mean values and standard deviation cervical, thoracolumbar, hip, knee, and ankle range of motion were presented in tables below. The range of motion mean values at all joints mentioned above for nonfallers were greater than fallers except eversion at ankle joint. However, only mean values for all thoracolumbar spine range of motion, hip extension, abduction, internal and external rotation, and ankle dorsiflexion were found statistically significantly different between two groups.

Table 1. Cervical joint range of motion

Variables	Fallers	Nonfallers	p
Flexion	38.7±5.7*	40.6±6.4	.5
Extension	33.6±8.4	35.3±7.8	.6
Side Bending Right	13.7±7.0	15.1±6.1	.6
Side Bending Left	12.1±9.3	15.6±7.6	.3
Rotation Right	30.9±5.4	31.9±6.1	.6
Rotation Left	29.8±6.4	30.4±7.8	.8

*mean±SD

Table 2. Thoracolumbar joint range of motion

Variables	Fallers	Nonfallers	p
Flexion	2.6±1.0*	3.5± .9	.02
Extension	2.4±1.2	3.3± .5	.02
Side Bending Right	6.4±3.1	10.1± 3.5	.01
Side Bending Left	6.7±2.9	10.0± 3.5	.01
Rotation Right	7.8±4.3	18.6±10.4	.003
Rotation Left	7.1±4.6	15.8± 8.4	.004

*mean±SD

Table 3. Hip joint range of motion

Variables	Fallers	Nonfallers	p
Flexion	101.6±12.2*	101.8± 9.7	0.9
Extension	3.1± 2.3	5.1± 3.0	0.006
Adduction	4.1± 2.3	5.2± 2.8	0.1
Abduction	18.4± 5.3	25.2± 6.8	0.0001
Internal Rotation	19.1± 8.8	29.1±10.8	0.0005
External Rotation	36.3± 5.9	39.7± 4.6	0.01

*mean±SD

Table 4. Knee joint range of motion

Variables	Fallers	Nonfallers	p
Flexion	137.5±8.7*	138.4±4.8	.6
Extension	-6.6±5.5	-1.0±1.8	1.1

*mean±SD

Table 5. Ankle joint range of motion

Variables	Fallers	Nonfallers	p
Dorsiflexion	11.4±5.7*	18.5±3.5	0.002
Plantarflexion	35.6±7.4	36.1±4.4	0.7
Inversion	22.1±6.2	22.8±7.8	0.7
Eversion	13.0±4.9	11.4±2.8	0.17

*mean±SD

Discussion

Falls are a major cause of decreased mobility and independence in the elderly and have been cited as an independent predictor variable leading to nursing home admission and hospital admission (Lee and Kerrigan, 1999). Moreover, falls are a leading perpetrator of accidental deaths among adults older than age 65 years. Balance impairments were found to be a significant risk factor associated with increased risk for falling in elderly. Balance often becomes impaired as one grows older (Hughes et al, 1996). A number of physiological changes accompany the normal aging process. Decrease in joint flexibility is one of the changes that are found in elderly.

Flexibility is a foundation for a free movement at every joint. Flexibility in joint movement allows for a person to accommodate various postural responses. In normal adults, the anteroposterior and lateral stability is required to maintain balance. While distal to proximal sequencing in response to platform perturbation appears to be the predominant pattern, a higher incidence of proximal to distal sequencing in the older adult has been observed. The difference in postural control mechanism with aging may be due to the change in their joint flexibility. The severe limitation of joint motion will be constrained by the biomechanical apparatus through which postural response must be expressed (Chandler and Duncun, 1993). The result of the range of motion comparison between two groups indicates that flexibility of the thoracolumbar spine, hip and ankle joints may be related to fall in the elderly. These results tend to support Shephard's (1984) observation that the decline in joint flexibility is accompanied by decrease instability and mobility, and by an increase in deformity. Gu and associates (1996) suggested that there are larger anteroposterior shear forces at the hip joint and upper body segment rotation in the elderly for maintenance of balance. Alexander and associates (1992) also suggested that there is increased use of trunk motion for maintenance of balance in the elderly. The conclusion of these two studies may explain the result of this study that there is a significant difference in range of motion between the fallers and nonfallers. Since elderly uses hip and trunk for postural control to maintain balance, flexibility at these joints may be necessary for elderly to maintain balance.

The dorsiflexion of ankle joint motion

was one other range of motion value that was significantly different between two groups. For all age group of adults, ankle joint plays important role in maintaining balance. The center of gravity is protuberated backward and forward, and the body moves as a relatively rigid mass about the ankle joints, like an inverted pendulum, to bring the center of gravity back over the base of support (Chandler and Duncun, 1993). This postural response occurring at ankle joint is known as an ankle strategy. Anacker and associates (1992) addressed the importance of ankle proprioception to allow postural control and decrease in fall in elderly.

James and Parker (1989) investigated the variation in joint range of motion throughout the life span and concluded that all lower limb joint motions became less mobile with increasing age, with largest change in ankle dorsiflexion. As James and Parker (1989) has indicated, the greatest limitation appeared in dorsiflexion for both fallers and nonfallers with greater limitation showed in nonfallers. Since the ankle joint plays an important role in providing anteroposteral postural control, fallers who had greater limitation at ankle joint may not have adequate postural control available to maintain balance. The flexibility into dorsiflexion range of motion may be necessary for the elderly to perform postural control to maintain balance.

The hip and knee flexion range of motion between fallers and nonfallers were different but not significantly. The fallers had decreased flexibility compare to non fallers. However, they were all within functional limit, greater than 90 degrees of flexion. The flexion range of motion at hip and knee joints may not affect the balance as long as they are within functional limit. However, it is unclear how hip and knee flexion range of motion will effect the balance as they decrease below the functional range.

The result showed there is no significant difference between cervical range of motion of fallers and nonfallers. The correlation of cervical range of motion between fallers and nonfallers deserves further study. This insignificance may be due to the limitation of this study. The sample size of the study is small and this may have limited the power of study. Also there was unequal distribution of men and women between two groups. Nonfallers group had man and woman while fallers group had no man but all women. Gender related differences in joint mobility are well documented. Women are more mobile than their male peers cross the age range (James and Parker, 1989). This unequal distribution of men and women between the two groups may have affected mean value of range of motion. Moreover, the study population was relatively functionally impaired elderly. Thus the result may not showed a huge difference in all areas of range of motion.

In conclusion, there is a flexibility difference between fallers and nonfallers. This difference may be related to fall in the elderly. The areas of range of motion that need considerations are thoracolumbar spine, hip and ankle joints. The results also showed that range of motion at thoracolumbar spine and hip joints not only differ in anterioposterior direction but also in mediolateral and rotational directions. Since variety of postural response strategies occur in multiple directions, flexibility at trunk, hip and ankle may be necessary for elderly to maintain balance in a complex environment. However, it is difficult to make a conclusion that there is a direct relationship between range of motion and postural control. As many studies have indicated, postural control is a complex control that depends on many factors besides range of motion. With increase in elderly population, there is a pressing need to develop therapeutic measures for elderly to preserve their physical capacities and promote functional ability (Gehlsen and Whaley, 1990 a,b). Physical therapist plays a central role in testing and implementing fall and immobility prevention; therefore further research is required to explore the effect of joint limitation on postural reaction and falls in elderly.

Acknowledgment: Thanks are expressed to Yeo Ju-hyun and Kim Hyung-nam, freshmen at Seoul Health College for their help during data collection.
This work was supported by Seoul Home of the Aged and Book-Bo Welfare Center for the Elderly.

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