Differences in Gait and Strength in Elderly Subjects with Osteoporosis and Kyphosis

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Introduction

Osteoporosis is, and will continue to be, a major health concern for the population. Falls in combination with low bone mass result in over 200,000 geriatric hip fractures each year in the U.S. Imbalance and tripping over obstacles during gait were reported as two of the most common causes of falls in the elderly. Balance may be a factor which can respond to intervention and result in reduction in risk of falling.

Statement of Clinical Significance

This study reports on the influence of osteoporosis and kyphosis on gait unsteadiness in elderly individuals.

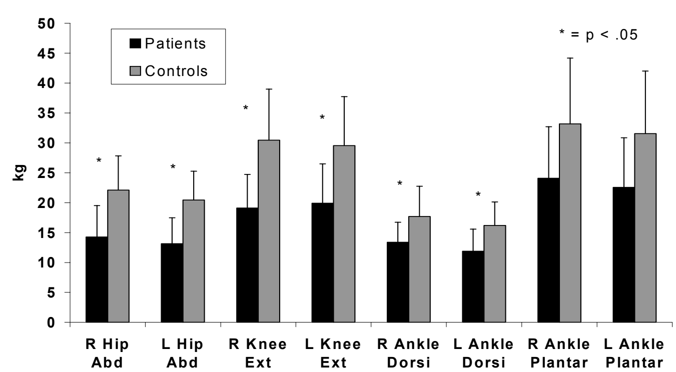
Methodology

Gait and strength data were collected from 11 (11 females) elderly subjects with osteoporosis and kyphosis (O/K) and 11 (9 females and 2 males) elderly healthy subjects (controls). The O/K subjects had a mean age of 76 (±5) and the normal subjects had a mean age of 71 (±6). The mean height for the O/K subjects was 157 (±3) cm and weight was 60 (±8) kg, while the control subjects mean height was 163 (±10) cm and weight was 70 (±11) kg. Isometric strength data was collected using a Quantitative Muscle Assessment (QMA) system (The Computer Source, Gainesville, GA). The subjects were studied during unobstructed level walking and while stepping over an obstacle of four different heights randomly assigned (2.5, 5, and 10% of the subject's height). A ten-camera Real Time system (Expert Vision, Motion Analysis Corp.) was used to collect 3-D marker trajectory at 60 Hz during gait from 28 reflective markers. EVa software (Motion Analysis Corp.) was used to track the trials and create virtual marker trajectories, which were used to define joint centers. A customized MATLAB program calculated the whole body COM based on a 13-link biomechanical model of the human body. The center of mass (COM) displacements and velocity was calculated in three orthogonal directions. OT4 (Motion Analysis Corp.) was used to calculate temporal distance parameters. A repeated measures ANOVA was used for the statistical analysis with the significance level set at $p<0.05$.

Results

The strength data demonstrated that overall, there is a significant difference in strength ($p=0.03$). The controls are stronger on all muscle groups tested (figure 1). There is a significant difference in the COM A/P and COM M/L displacements as well as in the Max A/P velocity. The results show that the O/K subjects had less A/P displacement,

Figure 1: Isometric Strength Results



greater M/L displacement and a reduced A/P velocity when compared to the controls. This was true for all conditions of unobstructed and obstructed level walking. Also, there is a significant effect of obstacle height on all COM parameters. Finally, there is no significant interaction for any of the COM parameters between the groups and the obstacle heights. When analyzing the temporal-distance parameters between the two groups there was a significant difference in the R and L step length, stride length, and velocity (table 1). Even though we did detect differences in the COM displacements, there was no significant difference in the R or L single support time or the step width, which are usual indicators of balance problems.

	O/K	Controls	P Value
Parameter	Mean (SD)	Mean (SD)	
R Step Length Avg (cm)	57.87 (3.66)	62.03 (3.00)	0.009
L Step Length Avg (cm)	57.35 (2.39)	62.23 (3.61)	0.001
Stride Length Avg (cm)	115.22 (4.75)	124.26 (5.81)	0.001
Forward Velocity Avg (cm/s)	103.11 (14.95)	117.79 (8.45)	0.01
Cadence Avg (steps/min)	107.24 (13.77)	113.79 (6.71)	0.17
R Single Support Time (%)	36.11 (1.49)	36.88 (2.07)	0.33
L Single Support Time (%)	35.43 (1.13)	36.00 (1.11)	0.25
Step Width (cm)	8.78 (1.57)	8.82 (2.03)	0.96

Table 1: Temporal Distance Parameters

Discussion

Epidemiology of falls has shown that about 50% of the falls occur during some form of locomotion. However, only a few studies on dynamic balance control were performed during locomotion and were limited to unobstructed level walking. MacKinnon found an active hip abduction moment about the supporting leg played a crucial role in maintaining balance of the trunk and swing leg. We found the O/K subjects had significantly less hip abduction strength, which may be the cause of the difference in the M/L displacement. The other COM differences may also be due to the decreased strength of the O/K subjects. According to Kaya, healthy elderly adults limited momentum generation of the whole body by decreasing gait velocity, however, excessive lateral momentum was found in balance-impaired elderly adults. This is consistent with our findings. Postural stability and balance performance decrease with age, and there is lack of knowledge concerning how dynamic stability of the whole body is maintained during balance-challenged ambulatory tasks, such as obstacle crossing. Objectively, the differences in balance, gait and strength in subjects with Osteoporosis and Kyphosis have not been adequately studied. More research needs to be done to better understand the affect that osteoporosis and kyphosis may have on gait.

References

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