The relation of the trunk-pelvic movement and lower extremity joint moment on elderly people during the sit-to-stand motion

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INTRODUCTION

The sit-to-stand motion (STS) is one of the most frequently executed activities although it poses a high risk of falling in elderly. It can be said that an important factor essential to improving movement ability is related to the acquisition of STS during practical activities such as transferring and walking. The purpose of this study was to create a physical therapy strategy related to properly supporting oneself during STS by making a clear relationship between trunk-pelvis movement and lower extremity joint moment.

METHODS

Fourteen elderly subjects (mean age 82.1) with no prior history of CNS-related diseases were recruited for this study. All subjects were able to perform STS without using their arms when the height of the chair equaled the length of their lower leg. Markers were placed on various parts of the body (top of head, tragus, acromion, lowest rib, ASIS, PSIS, great trochanter, lateral knee joint line, lateral malleolus, calcaneal tuberosity, and tip of toe). The movements of the markers on the sagittal plane were taken by a digital video camera (Sanyo, KDR2004) at 30 frames/s, and processed using a picture analysis software (NIH Image). By looking at the data points, the center of gravity (COG) and joint angles were calculated. The center of pressure of the buttocks and foot, and the vertical floor reaction force were measured at a frequency of 30Hz, using 2 force plates. This data was synchronized using an optical stimulus, and the time series behavior of the hip, knee, and ankle joint moments were measured.

RESULTS AND DISCUSSION

Eleven elderly subjects used the predominant hip extension moment during STS, while the other 3 subjects used the predominant knee extension moment from buttocks-off to motion termination. Here, we designated the former subject group as H, and the latter subject group as K. Comparison of the H and K-groups during STS was performed using Mann-Whitney's U Test. In comparison to the H-group, the total STS time of the K-group had a tendency to be longer (p=0.06), while the maximum horizontal velocity and anterior pelvic tilting angle at buttocks-off had a tendency to become smaller (p=0.06, p=0.07). Hip flexion angle and knee extension moment at buttocks-off were significantly larger ($p<0.05$). Hip extension moment and ankle flexion moment at buttocks-off were also significantly smaller ($p<0.05$). The data results show that the K-group is unable to use the kinetic energy of the trunk at the hip during STS, but rather uses the motion of the predominant knee extension moment. Specifically, the pelvic movement had an effect on the lower extremity joint moment. It is suggested that during smaller pelvic anteversion STS, the kinetic chain between the pelvic and lower extremity movement is easily broken, and therefore knee extension moment predominates after buttocks-off.

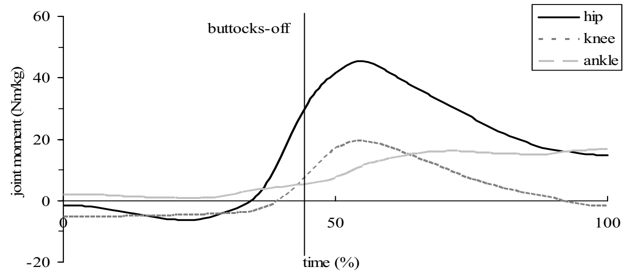

Figure 1: **Lower extremity joint moment in H-group.**

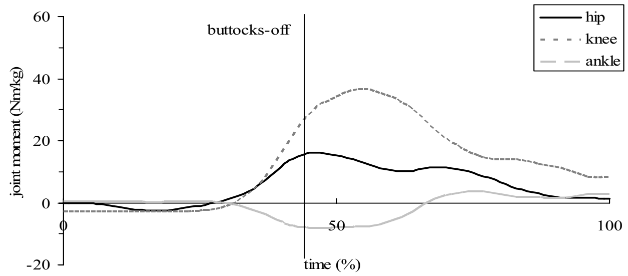

Figure 2: **Lower extremity joint moment in K-group.**

CONCLUSION

In order to make a practical physical therapy strategy for STS, it is necessary to facilitate not only lower extremity extensor muscle strength, but also the kinetics chain which links the pelvic and lower extremity movement.

Table 1: Comparison of H and K-groups

		H-group (n=11)	K-group (n=3)	
Total STS time(s)		2.38 ± 0.53	3.16 ± 0.68	
Maximum velocity (cm/s)	Horizontal	47.9 ± 10.0	33.8 ± 10.7	
Joint angles at the buttocks off (deg)	Pelvis	26.9 ± 8.7	14.9 ± 11.0	
	Hip	112.0 ± 9.4	125.1 ± 9.6	*
	Knee	87.5 ± 5.5	99.0 ± 1.2	*
	Ankle	10.8 ± 5.4	18.7 ± 2.0	*
Joint moment at the buttocks off (Nm/kg) [a)]	Hip	0.91 ± 0.19	0.41 ± 0.05	*
	Knee	0.30 ± 0.14	0.65 ± 0.14	*
	Ankle	0.08 ± 0.14	-0.19 ± 0.10	*

Mean±SD, *: $p<0.05$

a) each joint moments are normalized by dividing the raw data by the subject's body weight.