KINEMATIC AND KINETIC INDICATORS OF MOVEMENT DURING SIT-TO-STAND IN HEALTHY YOUNG AND OLDER ADULTS

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INTRODUCTION

Sit-to-stand (STS) is an essential transition for daily activities, which may be challenging for older adults with functional limitations to perform without upper body momentum, upper extremity assistance or external support (Schenkman, et al., 1996). Slow performance of the STS movement is associated with fall risk in older adults (Nevitt, et al., 1989).

Sit-to-stand may be divided into four phases: initiation, ascension, stabilization and termination. To evaluate the duration of STS, it is necessary to determine the point of initiation and termination of movement. In order to compare STS patterns in different populations, normalizing movement curves to a reference of the start of ascension (seat-off) is also essential. There is variation among authors regarding movement indicators for the beginning and ending points of each phase of STS movement (Schenkman, et al. 1996; Mourey, et al. 2000; Gross, et al. 1998).

Depending on laboratory instrumentation, there may also be variation in the available kinematic and kinetic measurements of STS performance. The purpose of this project was to determine which kinematic variables are appropriate to use as movement indicators for the analysis of sit-to-stand in healthy older adults in the absence of seated kinetic measures.

METHODS

Two young adults (35.0 ± 1.4 yrs) and two healthy older adults (70.5 ± 2.8 yrs) participated. An eight-camera system was used to track reflective markers for 3-D kinematic analysis. Subjects were positioned on a bench-mounted force platform at a height of 46.5 cm to measure seated reaction forces. With their feet at a comfortable width on separate force platforms to record ground reaction forces (GRFs), subjects performed sit-to-stand with initial foot placements of 90° of knee flexion, 100° of knee flexion, right-staggered and left-staggered. Subjects performed three trials in each condition. Kinematic variables included marker positions, marker velocities, joint angles and joint angular velocities.

Individual trials were evaluated using MATLAB for thresholds in kinematic variables and kinetic variables as indicators for sit-to-stand movement initiation, seat-off and movement termination (Figure 1). Comparisons were completed between young and older adults in terms of timing variation between movement indicators.

RESULTS AND DISCUSSION

Based on seated GRFs, trunk angular velocity exhibited a time lag (0.04 ± 0.18s) from initiation for all subjects. Hip marker positions showed timing leads with respect to seat-off (-0.14 ± 0.06s and -0.11 ± 0.07s for horizontal and vertical positions, respectively) for both groups.
CONCLUSIONS

It appears that the movement indicators for STS are consistent in both healthy young and older adults. Trunk angular velocity appears to indicate initiation and hip marker positions appear to indicate seat-off for both groups.

Indicators for STS termination may be less consistent due to high variability. In terms of kinematic variables, hip angle and hip vertical position may have the greatest potential as indicators of STS termination due to small time shifts and relatively small standard deviations. Hip marker horizontal velocity may require a higher terminal threshold, as the time lag for this indicator was larger than all other variables. Anterior-posterior GRFs may be a kinetic indicator of termination with similar timing shifts to the kinematic variables.

High variability in the termination indicators may also be representative of an inappropriate reference variable. Vertical GRF from the lower extremities may not be an appropriate determinant of STS termination, due to the oscillations during the stabilization phase of STS. Further research should investigate alternate kinetic and kinematic measures as potential determinants of STS termination.

REFERENCES