TRUNK SEGMENT KINEMATICS DURING LIFTING IN YOUNG AND ELDERLY INDIVIDUALS

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INTRODUCTION

The trunk is a multi-linked kinematic chain as determined by skeletal and muscular anatomical relations. While whole trunk motion is well studied elderly in postural control few differentiate inter-segmental trunk kinematics or investigate elderly lifting characteristics (Alexander et al 1992; Henry et al 1998). It is possible that segmental trunk kinematics may contribute to global trunk behaviour in elderly balance issues. This study was designed to determine segmental trunk kinematics during a lifting task in a young and elderly population. We hypothesized that segmental contribution to trunk motion may be affected by age.

METHOD

Nineteen young (27 ± 6 years) and twelve older subjects (70 ± 4 years) participated in the study. Ethical approval was obtained and all subjects gave written informed consent. Five electromagnetic sensors (Motion Star Ascension Tech, USA) were placed on C7, T10, L1, S2 and the right thigh. Position and orientation data were sampled at 86Hz, low pass filtered at 5Hz and computed to five trunk segments (Trunk: C7-S2, Pelvis: S2, Lumbar spine: S2-L1, Low thorax: L1-T10, Upper thorax: T10-C7) using MatLab (MathWorks MA, USA). Subjects were asked to transfer a box (4.5Kg) from a bench to shelf to the rhythm of a metronome (40 beats/min). Two trials were performed by each subject with a 2 minute rest period. Four phases for the lifting cycle were determined by a contact switch on the bottom of the box; transition-up, rest-on-shelf, transition-down and rest-on-bench. These were further subdivided into four motion events: off-bench, to-shelf, off-shelf and to-bench. Coefficient of variation (CV) scores for the two trials were calculated to determine subject variability. Displacement kinematics were determined for the trunk and pelvis and angular kinematics analyzed for all five trunk segments. Multivariate ANCOVA with repeated measures were used to analyze the pooled data from the two trials (significance level $p < 0.05$).

RESULTS

All intra-subject CV scores for displacement and angular kinematics were low (≤ 0.35). Inter-subject CV scores for displacement of the trunk and pelvis were also low (≤ 0.55) except the young pelvic displacement (0.69) (CV scores ≤ 0.60 were considered low Winter 1984).

Inter-subject CV scores for the upper thorax and trunk angular kinematics were low (≤ 0.47) while for the pelvis, lumbar spine and low thorax they were high (≥ 0.73). Elderly CV scores were lower than the young and pelvic CV scores higher than the trunk.

Displacement kinematics: The trunk oscillated in a bi-phasic pattern while the pelvis oscillated in a quad-phasic pattern (Figure 1). The pelvis displaced in the opposite direction to the trunk during mid phase of the transition cycle and in the same direction for box contact and lift. The

elderly displaced the trunk more than the young subjects for all four motion events. This was significant for off-bench, to-shelf and to-bench ($p = 0.002$; $p = 0.03$; $p = 0.004$). The elderly displaced the pelvis significantly more compared to the young for off-bench and less for to-shelf ($p = 0.03$; $p = 0.01$).

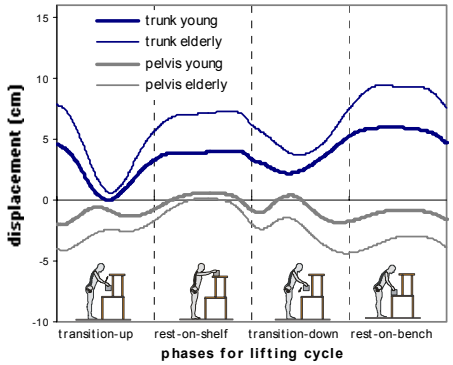

Figure 1. Trunk and pelvic displacement kinematics, young and elderly. The zero line indicates neutral stance for trunk and pelvis.

Angular kinematics: Young and elderly angular kinematics are shown in Figures 2 and 3. Low thorax spinal motion for the elderly subjects was less than the young for all four motion events. This was significant for to-shelf and off-shelf ($p \leq 0.001$; $p = 0.01$). Trunk and pelvic angle were significantly diminished for the elderly

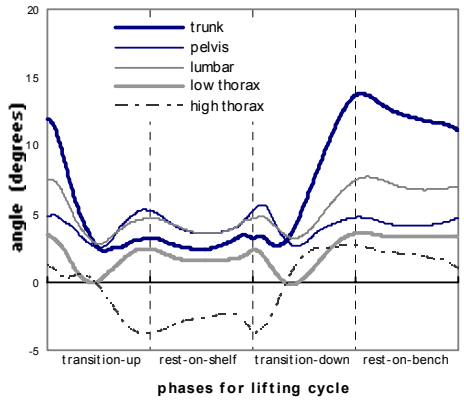

Figure 2. Trunk, pelvic, lumbar spine and thorax angle, young subjects.

compared to the young for the to-shelf motion only ($p = 0.02$; $p = 0.003$). Lumbar and upper thorax range were unaffected by age for this task. The upper thorax extended and flexed opposite to the lower segments during to-shelf and off-shelf. The upper thorax displayed significantly greater motion than all lower segments for off-bench and to-bench ($p < 0.005$).

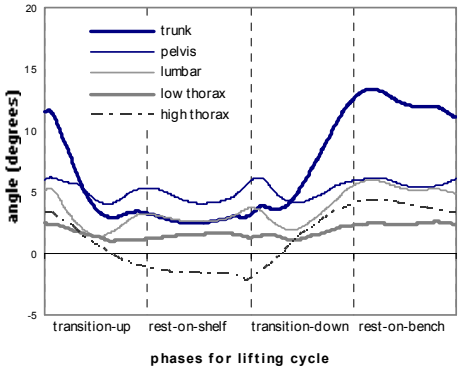

Figure 3. Trunk, pelvic, lumbar spine and thorax angle, elderly subjects.

DISCUSSION

Lower CV scores for the elderly compared to the young may indicate diminished options for trunk control.

Upper thorax motion corresponded closely to the voluntary task while the lower segments contributed to the task and maintenance of equilibrium.

Decreased low thorax and kinematics in the elderly may have contributed to increased trunk displacement which could place the elderly at increased risk of falling during lifting from a bench to a shelf.

ACKNOWLEDGMENTS

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Erratum last paragraph:

Decreased low thorax and pelvic kinematics in the elderly may have contributed to increased trunk displacement which could place the elderly at increased risk of falling during lifting from a bench to a shelf.