Analysis of the Biomechanical and Neurological Controls Associated with Sit-To-Stand Transfer

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Introduction

- Sit-To-Stand (STS) movement is defined as a rapid transition from a large base of support (BOS) in a stable position, to a smaller BOS in a less stable position
- Due to weakened muscles or diseased joints, over 6% of community-dwelling older adults and over 60% of nursing home residents have difficulty accomplishing STS transfer independently
- Work using 2D musculoskeletal models have been used, however, in individuals with altered patterns such as stroke populations, a 3D model is needed
- A deeper understanding of the muscular mechanisms during STS transfer is needed, because current intervention techniques result in up to 40% of PT patients not having significant improvements in everyday tasks

Methods

- A detailed literature review was done of research related to STS transfer
- Data from these sources was compiled in a useful and cohesive manner in order to further understand the STS process

Phases of Sit-To-Stand Transfer

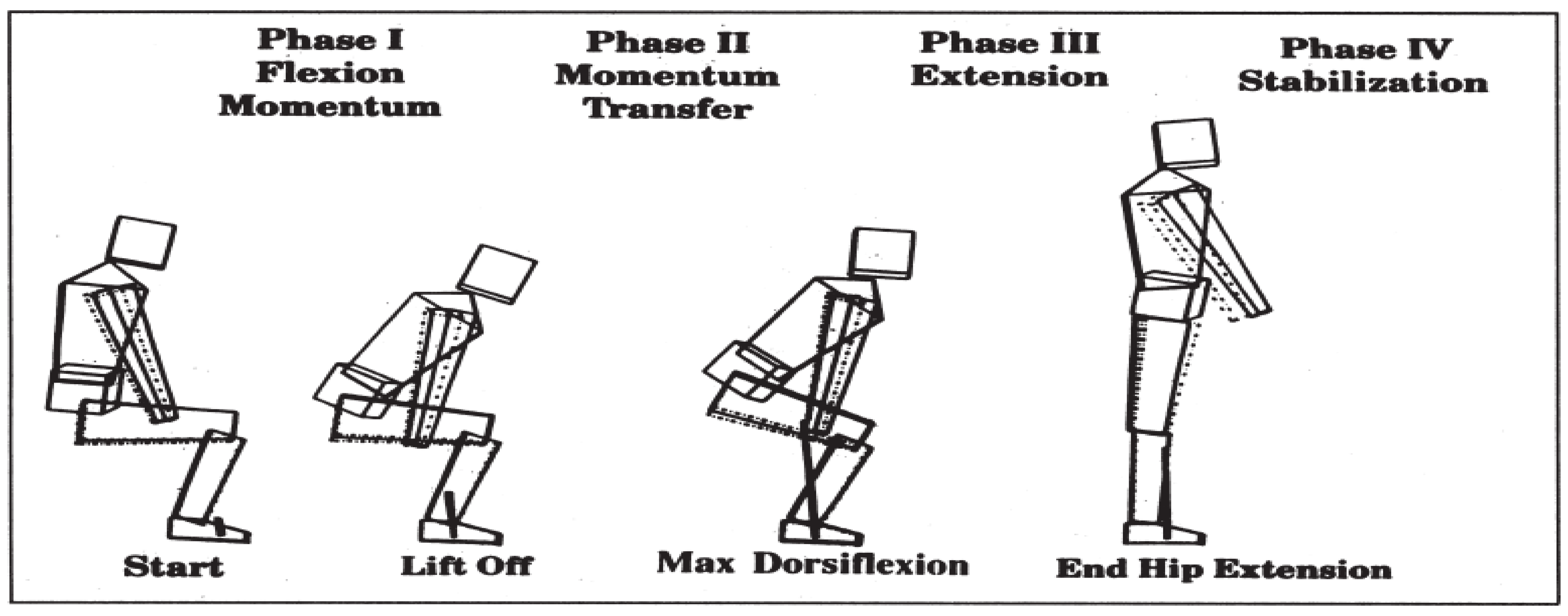

Figure 2: Four phases of rising marked by four key events. Because the arms are modeled AS single segments (using one array), the fact that the forearms are folded across the chest is not reflected in the figure.

Phase 1: Flexion Momentum Phase

- Begins with initiation of movement and ends just before the buttocks leaves the seat
- Primary event in this phase is trunk and pelvis rotation forward into flexion

Phase 2: Momentum Transfer Phase

- Begins when buttocks leaves the chair
- Maximum ankle dorsiflexion, trunk flexion, hip flexion, and head extension

Phase 3: Extension Phase

- Beginning defined by the attainment of maximum dorsiflexion
- Maximum hip-,trunk-, and knee extension velocities were reached

Phase 4: Stabilization

- Begins just after hip-extension velocity reaches zero
- Endpoint not easy to define, most subjects normally experience anterior-posterior and lateral sway

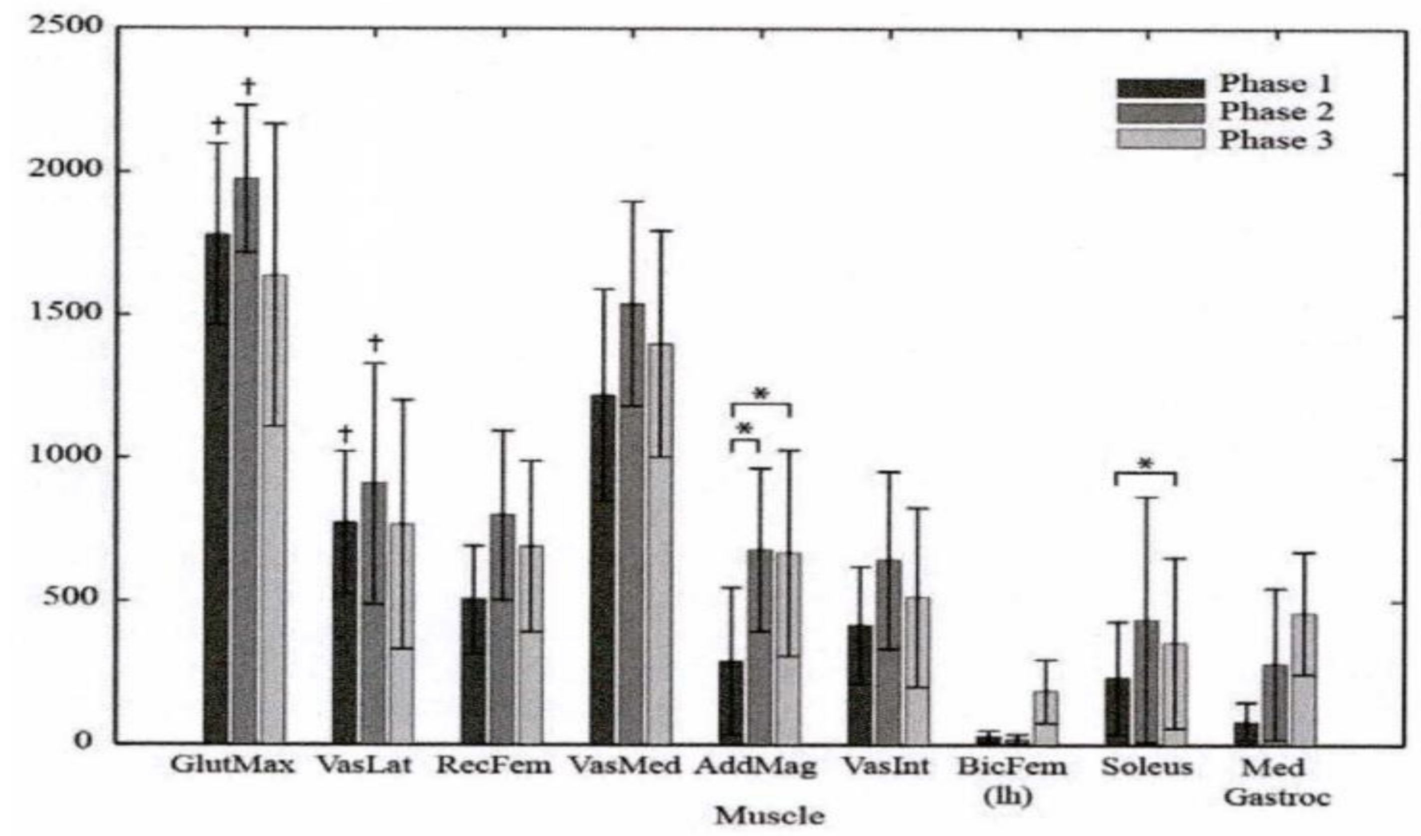

Figure 1: Average maximum muscle forces across 7 participants for each phase of transfer

Muscular Contributions in 3D Simulation

- The gluteus maximus and vastus lateralis generated significantly larger forces than all other muscles
- Rectus femoris produced forces significantly larger than that of the bicep femoris long head and plantar flexors
- Gluteus maximus was a large contributor to the vertical and upward motion of the Center of Mass (COM)
- Quadriceps opposed forward motion
- Soleus was largest contributor to vertical acceleration

Vision and Neurological Effects

	EO	EC
Weight transfer time (sec)	0.53 ± 0.27	0.40 ± 0.20**
Rising Index (% body weight)	28.10 ± 7.33	28.20 ± 7.47
Sway velocity (degree/sec)	2.81 ± 1.36	3.59 ± 1.10**

** Significant difference from EO ($p < 0.001$).

- Significant difference in mean weight transfer time when standing with eyes open (EO) versus eyes closed (EC)
- Significant difference in sway velocity
- The upright stance of a human is an unstable position
- Postural orientation involves the active control of body alignment and tonus in relation to gravity, BOS, and environmental references
- The main sensory systems involved are proprioception, the vestibular system, and vision, and their pathways within the CNS

References

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