

Kinematic Analysis of Sit-to-Walk Movement in a Fall-Prone Population

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Problem Statement: Despite the fact that falls comprise a large percentage of hospital injuries, little is known quantitatively about what induces patient falls, particularly with regard to hospital bed ingress/egress and bedside transitions. This is concerning since many studies conclude that over 50% of falls occur during activities related to leaving the bed and during in-room patient ambulation.

Objective: Since most fall studies to date have focused on qualitative measurements and assessments, the focus of our study was to quantify key temporal/spatial gait parameters in a fall-prone population during hospital bed egress.

Methods: Fourteen older adults (72.5 +/-10.1 years) were recruited with a history of falls (Morse Fall Scale value > 50). An 18-camera motion tracking system (NaturalPoint, Corvallis, OR) was used to track full-body biomechanics. Participants exited an adjustable, instrumented hospital bed without side rails at three bed heights calculated as a percentage of their lower leg length. Movements consisted of sit-to-stand transition and short ambulation from the bedside to a chair. As a control, the same events were captured from the chair (fixed height with arm rests) to the bed.

Results: Time to first step initiation (TFSI), defined as first toe-off following sit-to-stand, and time to first step (TFS), defined as first heel strike, showed significant differences in high bed and low bed conditions compared to the chair ($p < .001$). Participants took an average of one second longer to establish their first step during low bed conditions as compared to the control, and were about 1.5 s faster during high bed exits compared to the control.

Conclusion: Sit-to-walk is a challenging task for those at risk of falling since it requires a fluid sequence of dynamic postural and locomotor control and challenges stability. Emerging evidence indicates that populations at risk of falling have slower sit-to-walk times than young, healthy populations¹. This may be a key variable in evaluating an individual's postural control. Our results suggest that bed height may play a significant role in lengthening or shortening TFS/I during sit-to-walk motion and could influence stability. Selecting a patient-specific bed height could reduce fall probability resulting from instability during sit-to-walk transitions.

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Reference:

[1] Buckley TA, Pitsikoulis C, Hass CJ. Dynamic postural stability during sit-to-walk transitions in Parkinson disease patients. *Movement Disorders* 2008; 23(9): 1274–1280

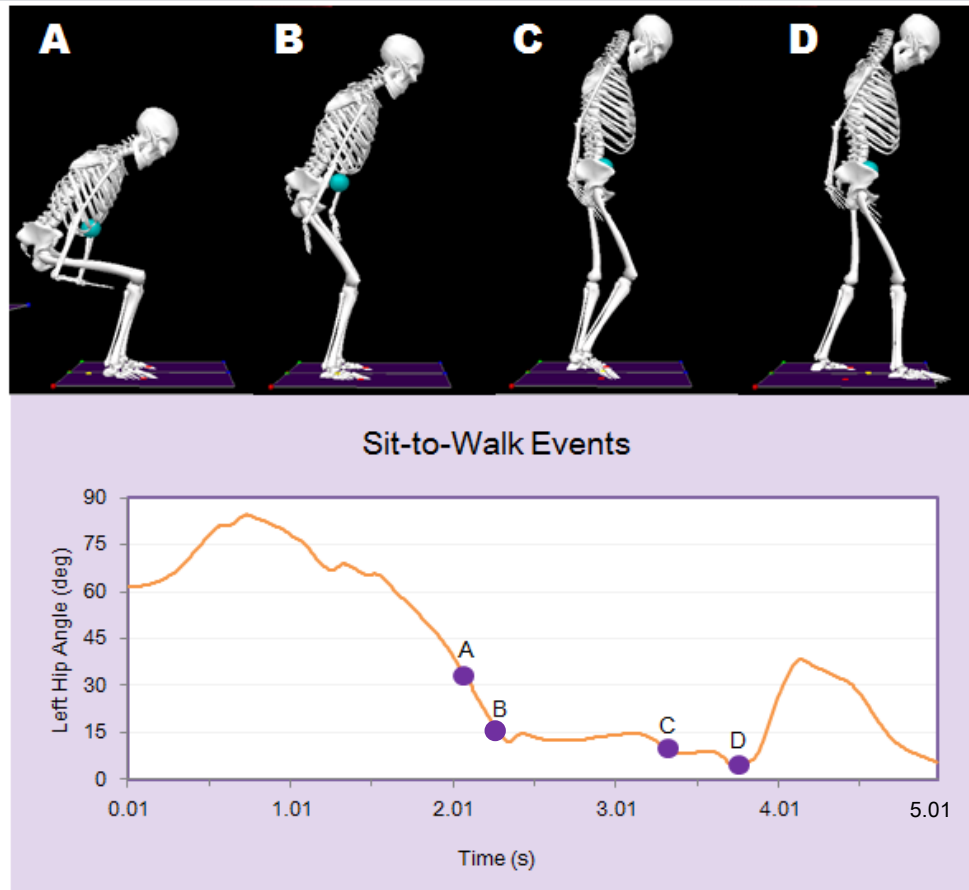


Figure 1, A) Sit-to-walk initiation determined as trunk velocity $> .01$ m/s in the Z direction. B) Transition phase between standing and walking. C) First step (initiation) determined by first toe-off. D) First step (actual) determined by first heel strike, often coinciding with maximum contralateral hip extension.