

BIOMECHANICS OF THE SIT TO STAND IN PEOPLE WITH MULTIPLE SCLEROSIS

Bradley Bowser, Sean O'Rourke, Lesley White and Kathy Simpson

University of Georgia Department of Kinesiology Biomechanics and Neuromuscular Physiology
Laboratories email: bowserbrad@gmail.com

INTRODUCTION

Rising from a seated position is one of the most common and functionally demanding activities of daily living and a prerequisite to other movements [1]. The-sit-to-stand (STS) requires balance, muscle strength, and coordinated contractions of the involved muscles [2]. People with multiple sclerosis (MS) often report symptoms of muscle weakness, disturbed balance and excess fatigue. However, the impact of such symptoms on daily activity performance remains less clear. Thus, the purpose of this study was to compare the kinematics and kinetics during STS transfers in a group of ambulatory individuals with relapsing remitting MS and a matched control group (CON).

METHODS

Thirty-three volunteers participated in the study (MS = 21; CON = 12). Individuals with MS (age=44±11.9 yrs, ht=166±6.9 cm, mass=79.1±19.8 kg) had physicians expanded disability status score (EDSS) of 6 or less. A group without MS, matched in age, height, and weight served as controls (CON) (age=42.8±11.8 yrs, ht=165.5±7.8 cm, mass=74.2±19.5 kg).

After obtaining informed consent, electromagnetic sensors were placed on the appropriate anatomical landmarks (sternum, sacrum, feet, shanks, thighs). Familiarization trials were performed. For the STS, participants began in standardized position with arms and hands folded across the chest, knee and ankle joints at 90°, and each foot on a separate force platform in a fixed position. The participant rose to a standing erect posture at a self-selected speed. Kinematic (Flock of Birds®: 100 Hz; LP filter 5Hz) and ground reaction force (Bertec®: 1000Hz; LP filter 200Hz) data were collected during 5 STS trials. Data from the most affected limb in the MS group were compared to the non-dominant limb of CON. Independent sample t-tests were calculated for total STS rise and phase times, selected maximum (max) kinetic and kinematic

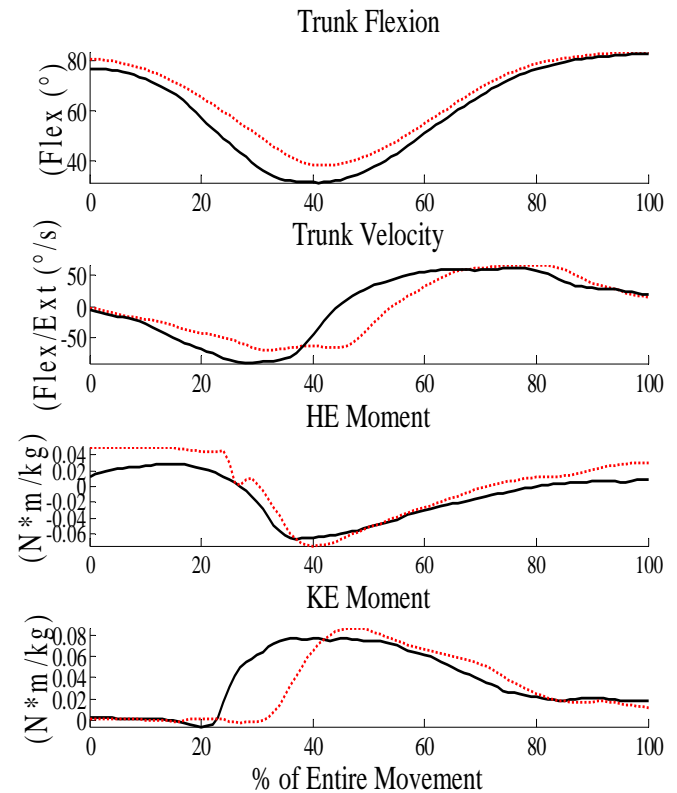


Figure 1. Representative trials of the CON (red dotted line) and MS (black solid line) groups for trunk angle, trunk velocity, HE and KE moments.

magnitudes, and relative time to these events. Bonferroni adjustments were made to control family-wise error associated with multiple t-tests. Significance was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Results are shown in Table 1 and displayed in Figure 1. Individuals with MS took longer to perform the STS task ($p < 0.05$) as indicated by increased time during the deceleration phase (P3) ($p < 0.01$). No group differences were observed for max knee extensor (KE) moments or velocities ($p > 0.05$); however, relative to the entire STS movement, the max KE moment occurred earlier for the MS group ($p < 0.05$). Similar results were found when examining the hip extensor (HE) moments.

Although no differences were found in max HE moments ($p>0.05$), a relatively earlier max HE moment ($p<0.01$) was found in the MS group. Additionally, the MS group displayed greater max trunk flexion, max trunk flexion velocity, and trunk extension displacement ($p<0.05$). No differences were found between groups for max KE velocity ($p>0.05$).

One possible explanation for the MS group having increased time in P3 (the phase made up of predominantly vertical motion) may be related to greater trunk extension displacement, which begins at max trunk flexion (shortly before P3 begins) and ends at the end of the movement. With no differences in max trunk extension velocity, it may take longer for the MS group to move the body through the larger range of motion to achieve the erect posture, thus resulting in a longer P3 time for the MS group. Another explanation for increased P3 time may be associated with reduced muscle function of the KE in MS during this phase. Concentric KE are the primary muscles used to raise the COM during P3 and largely determine the ability to perform STS [3]. Although no differences were found in the max KE moments, the earlier max KE moment in the MS group suggest less angular extension impulse generation from KE.

It appears that individuals with MS may use a compensatory movement strategy commonly displayed by individuals with lower extremity weakness and balance impairments, e.g., elderly, Parkinson patients [4, 5]. Although, the max HE

moments were not significantly different between groups, the MS group exhibited increased max trunk flexion and max trunk flexion velocity when compared to controls ($p<0.05$). Increased trunk flexion places the COM of the body closer to the center of the base of support (which encompasses only the feet during P3) thereby increasing stability. Increasing trunk flexion velocity is also suggested to increase horizontal momentum to transfer to vertical momentum [6] and therefore, reduce the load on the KE. The increased trunk flexion momentum that creates the forward momentum of the body may explain the relatively earlier max KE and HE moments found in the MS group.

People with MS displayed movement strategies that were consistent with those who have compromised balance and leg extensor strength [4, 5]. As the KE muscles are major agonists to raise the body upwards research is needed to determine whether strength training these muscles would be effective at improving the ability to perform the STS task in ambulatory individuals with MS.

REFERENCES

- 1.Kralj A, et al. *J Biomech* **23**, 1123-1138, 1990.
- 2.Mak MK, et al. *Clin Biomech* **18**, 197-206, 2003.
- 3.Bohannon RW, *Physiotherapy Theory And Practice* **23**, 291-297, 2007.
- 4.Papa E, et al. *J Biomech* **33**, 1113-1122, 2000.
- 5.Inkster LM, et al. *Exp Brain Res* **154**, 33-38, 2004.
- 6.Pai YC, et al. *Med Sci Sports Exerc* **23**, 225-230.
- 7.White LJ et al. *Mult Scler* **10**, 668-674, 200

Table 1. Displays differences between the MS and CON groups (Mean±SD)

Variable	MS	CON
Total STS time (s)	2.06±0.39†	1.76±0.22
P3 time (s)	0.91±0.29†	0.64±0.12
Max trunk flexion angle (°)	39±14*	51±9
Max trunk flexion velocity (°/s)	-92±26*	-73±19
Trunk extension displacement (°)	51±14*	39±9
Max trunk extension velocity (°/s)	74±16	70±17
HE moment (N·m·kg ⁻¹)	-0.067±0.02	-0.073±0.01
Rel. time to max HE moment (% of STS time)	34.5±6.8*	40.3±4.2
Max knee extension velocity (°/s)	116±27	138±30
Max KE moment (N·m·kg ⁻¹)	0.086±0.02	0.089±0.01
Rel. time to max KE moment (% of STS time)	40.5±8.0*	46.6±5.0

†Significantly different between groups ($p<0.01$). *Significantly different between groups ($p<0.05$).