Familiarization to walking on a split-belt treadmill: kinetics, kinematics and spatio-temporal parameters

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INTRODUCTION

The use of a split-belt treadmill with dual force plates provides a convenient means of collecting multiple gait cycles of motion and force data in a small volume. Subjects unfamiliar to walking on a split-belt treadmill may alter their normal gait pattern until they become accustomed to walking on such a treadmill. Previous familiarization studies on a conventional treadmill suggest that trunk kinematics stabilize after 4 minutes of walking at self-selected speed (Taylor et al., 1996) but that healthy young adults require a10-minute warm-up period before stride length is reproducible (Van de Putte et al., 2006). The purpose of this study was to determine which gait variables are altered when initially walking on the treadmill as well as to examine the changes in these gait variables over a nine minute period of treadmill walking.

METHODS

Nine healthy subjects were recruited to participate in the study (average age 24.1 yrs; range 20-32). Each subject participated in a single session of treadmill walking which lasted for nine minutes. Kinematic and kinetic data were collected from the first thirty seconds of each minute, beginning when the treadmill reached full speed. Walking speed was set at 1.25 or 1.30 m/s to allow for a comfortable walking pace.

Subjects were instructed to walk on the treadmill without using the handrails. They were asked to walk as they normally would while keeping each foot on a separate belt. None of the subjects had prior experience with walking on a split-belt treadmill.

Force data was collected at 600 Hz via two force plates integrated in the treadmill (Bertec Corp., Worthington OH). Kinematic data was collected at 60 Hz from reflective markers (Helen Hayes set) with a six camera system (Motion Analysis, Santa Ana, CA) and analyzed using Motion Analysis software. Differences between step width, step length variance and ground reaction forces between trials were determined using paired t-tests.

RESULTS AND DISCUSSION

A significant reduction in step width as well as a reduction in the variability of step length was seen as the subjects walked for a longer period of time on the treadmill. No significant changes were seen with step length, vertical ground reaction force, posterior ground reaction force (GRF) or knee flexion at heel strike for each subject throughout the nine minutes.

The reduction in average step width (Fig. 1) was found to be significant ($p<.01$) at the third minute. After five minutes, though, the average step width plateaued and remained constant. The variability of step length (Fig. 2) followed a similar trend, with the variability showing a significant change ($p<.02$) at minute three, but again leveling

off at after that. The average variability of step length increased again at the seventh minute. It is possible that this increase at the end of the session was associated with fatigue. Figure 3 demonstrates the lack of change in kinetic gait variables.

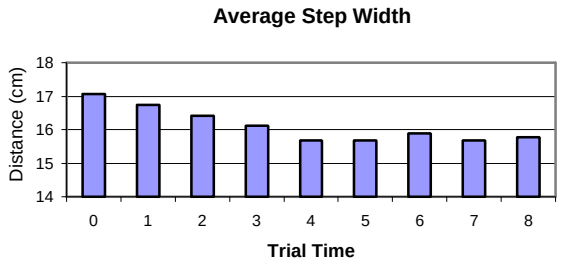

Figure 1. Trend of decreasing step width over the first four minute of walking

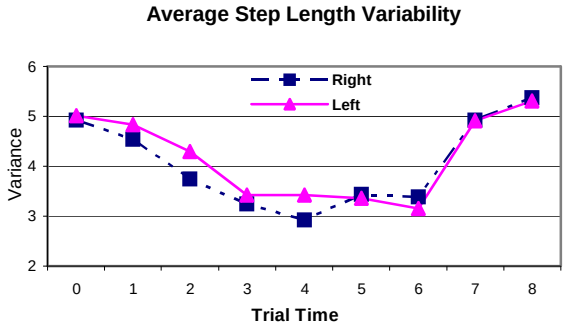

Figure 2. Average variability of step length decreasing over the first four minutes.

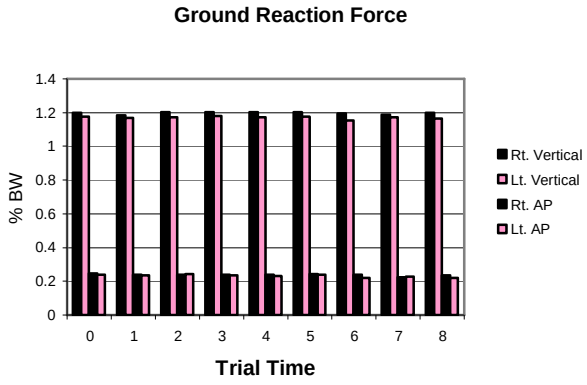

Figure 3. Vertical and AP GRF showing no familiarization trend with respect to time.

SUMMARY

The results of this study suggest that in order to collect accurate data for gait analysis, subjects should be familiarized to the treadmill prior to data collection. The amount of time that should be spent with familiarization to the treadmill is likely subject dependent, but the changes we found in step width and step length variability suggest the time should be at least four to five minutes. The results from this study support the findings of Matsas et al. (2000) who determined that there was no difference between sagittal plane kinematics in overground and treadmill walking after a six minute familiarization period. Even though variability persists throughout the nine minutes, we suspect the variability of step length is similar to what would be seen in overground walking.

Step width is a factor that should be given significant attention when using a split-belt treadmill. It is possible that a subject's initial anxiety of walking on a split-belt treadmill would result in an initial large step width. An elderly or injured population may have increased anxiety about the treadmill and proper precautions should be taken to allow for more accurate data collection. Verbal cues and enough practice time on the treadmill should be incorporated into future studies using a split-belt treadmill.

REFERENCES

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