INTRODUCTION

Essential tremor (ET) is one of the most prominent movement disorders in the adult population [1]. Persons with ET are typically characterized by an upper extremity action tremor which differs in origin and appearance from the resting tremor frequently observed in persons with Parkinson’s disease. However, recent research has expanded beyond tremor and upper extremity dysfunction and begun to highlight gait deficits in persons with ET [2, 3]. Most frequently, studies with gait analysis have observed marked cerebellar-like dynamic instability in persons with ET.

Despite the frequently-noted dynamic instability during tandem gait, relatively little attention has been given to variability in normal gait in ET. This is surprising considering the well-established associations between variability in gait and dynamic instability. Data from our lab has suggested that gait variability is significantly higher in persons with ET as compared to their neurologically-healthy age-matched peers. However, the clinical correlates associated with gait variability in ET and treatment options for normalizing gait variability in this population remain unknown. As midline tremor severity has been shown to be related to various gait and balance deficits in ET, we postulate that midline tremor severity may also be associated with increased gait variability and that these symptoms may be responsive to surgical treatment.

Deep brain stimulation (DBS) has been established as a successful treatment option for reducing intention tremor in persons with ET. While this therapy has been shown to significantly reduce tremor, the impact of DBS on gait and dynamic stability is unclear. As unilateral thalamic stimulation has previously been shown to reduce midline tremor in persons with ET, we hypothesized that these reductions in midline tremor after DBS may also reduce gait variability in this population.

The purpose of this study was to investigate associations between itemized clinical scores on the Fahn-Tolosa-Marin Tremor Rating Scale (TRS) and gait variability measures in persons with ET in order to determine clinical correlates of gait variability in this population. We also aimed to investigate the effects of unilateral thalamic DBS on gait variability in persons with ET.

METHODS

Twenty-three persons with ET (66 ± 8 yrs, 175.4 ± 13.2 cm, 92.3 ± 23.6 kg) walked on a split-belt treadmill (Woodway USA, Waukesha, WI) for five minutes at a self-selected comfortable pace. Eight of these participants (69 ± 3 yrs, 177.0 ± 11.0 cm, 98.8 ± 20.0 kg) also underwent implantation of unilateral DBS on the ventral intermediate nucleus of the thalamus for tremor relief. Six months following surgery, the participants returned to the lab with the DBS on and walked for five more minutes on the split-belt treadmill at the same speeds tested previously. Participants also completed the TRS on each testing day.

Stride length was calculated as the anterior-posterior displacement of the ankle marker from heel-strike to ipsilateral toe-off. Stride time was calculated as the time from heel-strike to the next ipsilateral heel-strike. Step length was calculated as the anterior-posterior distance between the contralateral ankle markers at heel-strike. Step time was calculated as the time between heel-strike and the next contralateral heel-strike. Step width was calculated as the medial-lateral distance between the ankle markers at heel-strike. We defined variability...
in each of these measures by the coefficient of variation (CV), calculated by dividing the standard deviation by the mean across the entire five minute trial.

Two-tailed Spearman’s correlations were performed to analyze associations between measures of gait variability and specific items of the TRS as well as between the pre-post change in gait variability measures and the pre-post change in specific items of the TRS in the participants who underwent DBS implantation. Related-samples Wilcoxon Signed Rank tests were performed to compare gait variability measures before and after DBS in the relevant participants. All levels of significance were set at α=.05.

RESULTS AND DISCUSSION

In the group of 23 persons with ET, stride length, stride time, and step length CVs were significantly associated with total TRS score as well as both resting and postural trunk tremor. Stride length and step length CVs were significantly associated with voice tremor.

After DBS, stride length, step length, and step time CVs were significantly reduced (Figure 1). The pre-post change in voice tremor was significantly associated with the pre-post change in step width CV. Pre-post changes in resting and postural trunk tremor were significantly associated with pre-post changes in stride time and step time CVs (Table 1).

CONCLUSIONS

Gait variability is significantly higher in persons with ET as compared to their neurologically-healthy peers. In this population, gait variability is associated with total TRS score and, more specifically, severity of midline tremors such as voice and trunk tremor. Gait variability is significantly reduced with DBS and reductions in the same midline tremors are associated with reductions in gait variability.

Deep brain stimulation appears to be an effective treatment to reduce gait variability in persons with ET through concurrent reduction of midline tremors. The effects of DBS on other gait characteristics remain controversial. Thus, further research is required to provide a more comprehensive understanding of the impact of DBS on locomotion in persons with ET.

REFERENCES


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<tr>
<th>Table 1.</th>
<th>Spearman’s correlation coefficients for associations between changes in TRS scores and gait variability measures after DBS.</th>
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