THE CHARACTERIZATION OF GAIT PATTERNS IN MULTIPLE SCLEROSIS

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INTRODUCTION

Multiple sclerosis (MS) is the most common progressive neurological disease in young adults [1]. In MS patients, motor deficits most commonly affect the lower extremities, with eighty five percent of MS patients reporting gait disturbance as their main complaint [2]. Clinical gait analysis serves to quantify functional changes associated with disease progression and locomotor handicap in MS, allowing for earlier clinical treatment and the prescription, or even personalized design, of appropriate assistive devices. Despite this, there are relatively few reports describing gait parameters in persons with MS, and most are confined to time-distance parameters and joint range of motion [3, 4], or use minimally impaired subjects [5]. It was the aim of this study to perform a full biomechanical characterization of gait patterns in people with MS, enabling the establishment of scientific criteria for the facilitation of gait in this population.

METHODS

30 people with MS (aged 26-53) were recruited for the study. Patients were initially evaluated by a physiotherapist for spasticity and joint range of motion. Following this, patients were invited to the biomechanics lab at the University of Strathclyde. Kinematic and kinetic data were collected and analyzed for the hip, knee and ankle joints using 8 Vicon 612 cameras, Vicon BodyBuilder software (Oxford Metrics Ltd., Oxford, UK) and 2 Kistler force plates (Kistler Instruments, Inc., Amherst, NY). Subjects were asked to walk a distance of 6 metres in flat shoes across the force plate. Three trials were taken for each leg and averaged. Muscle activation patterns were measured for the tibialis anterior, the medial and lateral gastrocnemius and the soleus using a Noraxon Telemyo 2400T wireless EMG system (Noraxon, Scotsdale, Arizona, USA). Footswitches were used to detect heel-strike and toe off and a minimum of 25 steps were recorded for each patient. EMG data were full wave rectified, smoothed at 30ms and normalized with respect to peak voltage for comparison purposes. An age and gender matched group of healthy participants was used as a control for statistical comparisons.

RESULTS AND DISCUSSION

EMG activity was found to be significantly greater in MS patients compared to the control group during the swing phase of gait for both the lateral (figure 1a) and medial gastrocnemius in most patients. Tibialis anterior activity (figure 1b) was significantly greater during early swing phase for MS patients. There is also a delay in maximum tibialis anterior activity at heel strike in MS patients which is likely to be a factor in the instability during stance phase, as well as contributing to foot-slap.

Figure 1: Average EMG activity of the Lateral Gastrocnemius (a) and Tibialis Anterior (b) in MS patients compared to a healthy control group.

The increased EMG activity that was apparent in the ankle plantar-flexor muscles in MS is thought to be a mechanism to counteract balance deficits and may have implications for both fatigue and spasticity. Table 1 indicates a reduction in hip flexion, ankle plantarflexion and maximum knee extension for MS patients. The greater knee flexion in the MS patient group at toe-off could inhibit propulsion and may be compensated for in orthosis design. The reduced ankle plantarflexion angle is thought to be a conscious effort by MS patients to prevent drop-foot by counteracting excessive plantar-flexor muscle activity, serving to reduce the risk of falling. This will result in excessive use of the tibialis anterior muscle (figure 1b) and may further contribute to fatigue.

CONCLUSIONS

Previously unquantified gait parameters specific to MS have been determined in this study and should be considered when facilitating locomotion in this patient group. Furthermore, recommendations for orthosis design and appropriate provision of electrical stimulation devices are more feasible after having established the typical impairments in this patient group.

REFERENCES


ACKNOWLEDGEMENTS

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Table 1: Summary of values for flexion/extension at the hip, knee and ankle joint for healthy control subjects and MS patients.

<table>
<thead>
<tr>
<th></th>
<th>Min Hip Flexion (Degrees)</th>
<th>Min Knee Flexion At Toe Off (Degrees)</th>
<th>Max Knee Flexion (Degrees)</th>
<th>Peak Ankle Plantarflexion (Degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Subjects</td>
<td>-15.6 (±3.8)*</td>
<td>-0.14 (±3.2)*</td>
<td>65.44 (±8.7)</td>
<td>-24.47 (±7.3)*</td>
</tr>
<tr>
<td>MS Patients</td>
<td>-6.86 (±7.4)*</td>
<td>6.24 (±6.8)*</td>
<td>63.23 (±12.8)</td>
<td>-12.22 (±11.5)*</td>
</tr>
</tbody>
</table>

Table 1: Summary of values for flexion/extension at the hip, knee and ankle joint for healthy control subjects and MS patients. Mean (StDev) * Indicates a statistically significant difference between control subjects and MS patients at p<0.05.