EMG RESPONSES DURING NEUROPATHIC GAIT IN TREADMILL: A CASE STUDY

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Introduction
Diabetic peripheral neuropathy is one of the most insidious chronic complications of diabetes and the consequences of that are present during many daily habits and locomotion. Biomechanical changes in neuropathic patient’s gait have been reported, as well motor strategies created to compensate their somatosensory deficits (Cavanagh et al. 1992; Amadio et al., 1997; Abboud et al., 2000). Biomechanical gait evaluation can detect early motor alterations in those patients and these biomechanical parameters could help the diagnosis and the treatment of the neuropathy (Sacco et al., 2000). The literature has been demonstrating the importance of the use of treadmill to gait analysis, physiological evaluation and for clinical and rehabilitation aims. It is pointed some advantages, like the bigger control of velocity, smaller physical space, successive gait cycle acquisition, standardized and reproducible protocol and variables during data acquisition. This paper aims at comparing the EMG activity in the leg and thigh muscles during treadmill locomotion between a healthy subject and a diabetic neuropathic patient.

Methods
We used a Gaitway treadmill (Kistler) (figure 1A) and six surface EMG electrodes (Delsys) (figure 1B) that were placed on the motor point of the lateral gastrocnemius, anterior tibialis, and lateral vastus of both legs.

Plantar pain tolerance, plantar sensitive cronaxie and motor cronaxie over the EMG muscles were determined using a pulse generator to verify abnormal responses. The subjects were: a 30yr. female, 72.8 kg, non-diabetic, without musculoskeletal injuries; and a 69yr. male, 67.1 kg, diabetic neuropathic for 18 yr. They were requested to walk over a walkway till they find a natural and more comfortable cadence. A walking cadence of 116 bpm was achieved overground by the control subject and it resulted in a treadmill self-selected velocity of 5 km/h. The diabetic neuropathic subject achieved an overground walking cadence of 100 bpm and it resulted in a treadmill self-selected velocity of 2.9 km/h. EMG signals were acquired 3 times at 1000 Hz for periods of 12 s, resulting in 30 supports for each foot. The EMG signal were rectified, filtered and normalized by the mean value and by support time. The EMG data were synchronized by the ground reaction forces in the treadmill. The experimental procedures were fully explained to the subjects and their written consent were obtained. The protocol was approved by the Ethical Committee of the University Hospital.
Results and discussion
The neuropathic subject presented higher values of sensitive cronaxie and motor cronaxie of the right lateral gastrocnemius altered from the normality. The pain tolerance over the heel, medial forefoot and hallux were significantly high. These findings showed that the neuropathic subject presented a distal motor and sensitive injury related to the sural, medial plantar and fibular nerves. The EMG pattern of the diabetic neuropathic subject was expressively different from the control subject (figure 2 and 3). We observed bigger time of activation of the lateral vastus for the neuropathic subject: for the right lateral vastus 76% of support time, and for the control subject, 32% of support time. And we also observed higher EMG magnitudes for the diabetic subject. The anterior tibialis activity of the neuropathic subject was shorter than the activity of the control (right: 65% of support time for the control and 35% % of support time for the diabetic neuropathic subjects). Lower magnitudes of the EMG were also verified for the anterior tibialis. The right lateral gastrocnemius activity of the neuropathic subject was delayed comparing to the control group: delayed in 27% of support time.

![Figure 2. EMG envelopes of the control and neuropathic subjects of the right (R) m. lateral vastus, m. anterior tibialis and m. lateral gastrocnemius.](image)

![Figure 3. EMG envelopes of the control and neuropathic subjects of the left (L) m. lateral vastus, m. anterior tibialis and m. lateral gastrocnemius.](image)

<table>
<thead>
<tr>
<th>CV (%)</th>
<th>m. lateral vastus</th>
<th>m. anterior tibialis</th>
<th>m. lateral gastrocnemius</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R L R L</td>
<td>R L R L</td>
<td>R L R L</td>
</tr>
<tr>
<td>Control</td>
<td>17.1 17.1</td>
<td>20.5 18.0</td>
<td>20.1 22.3</td>
</tr>
<tr>
<td>Diabetic</td>
<td>87.7 93.7</td>
<td>52.0 99.5</td>
<td>45.1 71.6</td>
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</tbody>
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Table1. Coefficient of variation (%) of the vastus lateral, anterior tibialis and lateral gastrocnemius EMG.
Another important aspect to detached is the higher coefficient of variation of the EMG of the diabetic neuropathic subject (table 1). The EMG pattern of the neuropathic subject showed to be more variable and unstable than the control subject and this could be due to the altered gait control in this subject. These results showed that the neuropathic subjects uses considerably more of the thigh muscles than the ankle muscles during the toe clearance and swing phase, specially his right side. MULLER (1994) also discussed the higher hip moments and lower ankle moments during neuropathic gait. This way, the neuropathic patients will use more the hip gait strategy than the ankle strategy. Further studies are being conducted to identify and certify that these EMG responses are coupled with dynamic parameters during gait.

References