Neuropathy and Gait Disturbances in Patients With Venous Disease: A Pilot Study

We studied less well-investigated components of the calf muscle pump failure associated with venous disease, including muscle, nerve, movement, and gait abnormalities.1 We investigated sensory neuropathy and ambulatory foot pressures in patients with chronic venous insufficiency (CVI) to further elucidate the pathogenesis and mechanisms of venous ulceration.

Methods. After institutional review board approval and informed consent, 10 patients with active noninfected venous ulcers or a history of such ulcers (CEAP [Clinical-Etiologic-Anatomic-Pathophysiologic]1 clinical classification 5 or 6) were recruited. No recruited patient had a history of neuropathy or predisposing conditions for neuropathy. Ten age-, sex-, and weight-matched control patients without diabetes or venous disease were also recruited from the same population. All patients had good arterial circulation and walked without assistance. A medical history was obtained and foot, leg, and ulcer examinations were performed on all patients.

To evaluate symptoms of peripheral sensory neuropathy, the validated neuropathy symptom score (NSS)2 was determined. To measure quantitative objective neuropathic changes, we performed quantitative sensory testing of the feet using the validated neuropathy disability score (NDS).2 As part of the NDS, we used a 10-g monofilament to perform sensory testing of the feet at 6 sites. Vibration perception threshold testing was performed using a biothesiometer and a 128-Hz tuning fork. Temperature discrimination and Achilles reflex were also tested.

Gait was analyzed by evaluating pedal pressures using the Novel Emed program and device (Novel Electronics Inc, Minneapolis, Minnesota),3 an electronic measurement system used to evaluate dynamic pressure distributions. This device uses calibrated capacitive sensors beneath a mat connected to a computer to analyze pedal pressures as subjects walk across the mat barefoot. Overall pressure for each patient was measured in kilopascals (kPa), as were localized pressures in 5 locations on each foot.

Results. Ten participants with venous disease and matched controls were enrolled, including 3 participants who had active disease bilaterally. We therefore evaluated 13 extremities with venous disease. Both the NSS and NDS were significantly higher in patients with venous disease than in matched controls (4 and 3.3, respectively, in the ulcer group and 0 and 0 in controls) (Table 1). Overall total foot pressure was significantly higher in the control group than in the ulcer group (756.93 kPa vs 630.38 kPa) (Table 2). The location of peak pressure was the forefoot for both groups. However, the ulcer group had significantly higher midfoot pressures and lower big toe pressures. We did not find a correlation between NDS or NSS scores and pedal pressure.

Comment. Patients with venous disease had both subjective and objective symptoms and physical findings of neuropathy to a greater degree than their matched controls, and this finding is consistent with other studies demonstrating peripheral sensory neuropathy in patients with CVI without diabetes.4 We also found that patients with CVI have an altered gait compared with that of controls.

Table 1. Descriptive and Inferential Results for NDS and NSS

<table>
<thead>
<tr>
<th>Score</th>
<th>Mean (SD) Score</th>
<th>Score Difference</th>
<th>Standard Error</th>
<th>t Statistic</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVI Group</td>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>3.30 (2.06)</td>
<td>0.00 (0.00)</td>
<td>3.30</td>
<td>.651</td>
<td>.989</td>
</tr>
<tr>
<td>NSS</td>
<td>4.00 (3.13)</td>
<td>0.00 (0.00)</td>
<td>4.00</td>
<td>.989</td>
<td>4.045</td>
</tr>
</tbody>
</table>

Abbreviations: CVI, chronic venous insufficiency; NDS, neuropathy score; NSS, neuropathy symptom score.

aBased on 9 df. Calculations were based on the sample of 10 patients.

Table 2. Descriptive and Inferential Results for Peak Total Foot Pressure

<table>
<thead>
<tr>
<th>Mean (SD) Pressure, kPa</th>
<th>Pressure Difference, kPa</th>
<th>Standard Error</th>
<th>t Statistic</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVI Group</td>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>630.38 (324.43)</td>
<td>756.93 (314.66)</td>
<td>−126.55</td>
<td>70.197</td>
<td>.097</td>
</tr>
</tbody>
</table>

Abbreviation: CVI, chronic venous insufficiency.

aBased on 12 df. Calculations were based on the CVI group sample of 13 limbs (3 of the 10 patients with CVI had venous disease on both limbs).
as measured by pedal pressures. To our knowledge, this has not been previously reported.

Patients with CVI had lower total foot pressures than the control group, even when controlling for weight, primarily due to differences in the higher midfoot and lower big toe pressures in the CVI group. This may be related to decreased range of motion previously reported in patients with CVI. The pattern of pedal pressures observed was distinct from the pattern of pedal pressures seen with diabetic neuropathy. Recently, surrogates of gait, including ankle range of motion and walk time, were found to decrease with increasing severity of venous disease among a subset of patients with venous disease (intravenous drug users who injected in their legs).  


Interestingly, in the present study, despite finding abnormalities in neuropathy and gait, we did not find an association between the two outcomes studied. This may suggest that gait changes are not a consequence of neuropathy but rather are due to other mechanisms, or the finding may be an artifact of our small sample size. Our results may have management implications, including simple, low-cost screening procedures for neuropathy using monofilaments in patients with venous disease, use of agents that target neuropathic pain, or the use of gait training and physical therapy to improve calf muscle pump function.

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Author Contributions: Dr Kirsner had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Newland and Kirsner. Acquisition of data: Newland and Kirsner. Analysis and interpretation of data: Newland, Patel, Prieto, Boulton, Pacheco, and Kirsner. Drafting of the manuscript: Newland, Patel, Pacheco, and Kirsner. Critical revision of the manuscript for important intellectual content: Prieto, Boulton, and Kirsner. Statistical analysis: Pacheco. Administrative, technical, and material support: Newland, Patel, and Kirsner. Study supervision: Newland, Prieto, Boulton, and Kirsner.

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Methods. A PubMed search was performed using the search terms diabetic, skin, ulcer, and lower extremity. Several questions on lower-extremity self-care practices and attitudes were adapted from existing survey instruments. Knowledge and other attitude questions (Figure 1, Table 1, and Table 2) were formulated using the specific guidelines of the National Institute of Diabetes and Digestive and Kidney Diseases to assure content validity. The survey was written in English (Figure 2) and translated into Spanish. The Spanish version was back-translated by a third person to assure correspondence in meaning.

Figure 1. Validated and reliable screening questions for lower extremity self-care practices of Latino adults with diabetes.