Ankle Impairments Seen in Diabetics Even Without Neuropathy

CME

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Disclosures

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Learning Objectives
Upon completion of this activity, participants will be able to:

1. Describe altered foot-ankle biomechanics associated with diabetes.
2. Compare ankle mobility and muscle strength in patients with diabetes with and without neuropathy.

Authors and Disclosures
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August 1, 2008 — New research indicates that even in the absence of peripheral neuropathy, patients with long-standing diabetes mellitus are prone to impaired ankle function.

The findings suggest that mechanisms besides neuropathy may play a role in altered foot-ankle biomechanics seen in diabetics, lead author Dr. Claudia Giacomozzi, from Istituto Superiore di Sanita in Rome, and colleagues state in the July 4th online issue of *BMC Musculoskeletal Disorders*.

The sensory and motor deficits that accompany diabetic neuropathy can compromise gait control, result in nerve degeneration causing muscle weakness and atrophy, and lead to plantar ulcers, the investigators note. Prior research has suggested that neuropathy is needed for altered foot-ankle biomechanics in diabetics, but due to various methodologic issues, definitive conclusions could not be reached.

In the present study, Dr. Giacomozzi's team addressed this topic by evaluating muscle performance and ankle mobility in 46 diabetics with and without neuropathy and in 21 controls under controlled conditions. The tests were conducted using dedicated equipment designed by the researchers, with the subject seated and the examined limb virtually unloaded.

Three-dimensional active ranges of motion and force moments were recorded, the authors note. The latter was performed during maximal isometric contractions with the foot blocked in various positions.

Compared to controls, ankle mobility was impaired in all of the diabetic patients. In the sagittal and transverse planes, ankle mobility was reduced by 11% and 20%, respectively, in diabetics without neuropathy compared with controls. The corresponding values for diabetics with neuropathy were 20% and 21%.

A significant drop in dorsal-flexing moments was also noted in diabetics with the greatest reductions being 28% and 37% for diabetics without and with neuropathy, respectively. Similarly, plantar-flexing moments were reduced by up to 15% for diabetics without neuropathy and up to 24% for those with neuropathy.

Further studies are needed to better understand the mechanisms responsible for the altered foot-ankle biomechanics in diabetics, the authors conclude. "From a clinical point of view, the findings...may help design ad hoc rehabilitative paths, in order to maintain an adequate level of gait performance in the presence of long-term diabetes, thus preventing excessive loading of foot tissues at risk of ulceration."

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Clinical Context

Peripheral neuropathy is a main cause of sensory and motor deficit in patients with diabetes. Nerve degeneration may cause muscle weakness and atrophy, leading to ulcers and limited mobility at the foot and ankle, but other causes may also be involved, such as hyperglycemia leading to tendon and fascial damage.

This is a controlled, experimental study of patients with longstanding diabetes with and without peripheral neuropathy vs healthy control subjects without diabetes to examine alterations in foot-ankle biomechanics and in strength and mobility. Functional alterations were measured with an ankle dynamometer under active unloaded conditions in patients who were seated.

Study Highlights

- Included were patients aged younger than 70 years with diabetes for at least 7 years and no history of peripheral vascular, neurologic, musculoskeletal, or rheumatic disease; amputation; or Charcot's neuroarthropathy.
- 46 patients with long-term diabetes were recruited, of whom 19 had neuropathy and 27 did not have neuropathy.
- Diabetic neuropathy was defined as a Neuropathy Disability Score of more than 5 and a Vibration Perception Threshold of more than 25 V.
- 21 healthy control subjects were recruited for comparison.
- Calluses, if any, were removed before testing.
- The authors designed an ankle device to test linear and angular displacements of the foot according to the shank or moments of force after blocking of the foot during isometric contractions.
- The device was balanced and patients worked under unloaded conditions.
- Angular displacements were measured in all 3 planes of the reference system with use of commercial high-precision angular potentiometers.
- During the measurement, patients sat on a chair rigidly fixed to the wooden platform of the device with the right shank aligned to the first link of the device.
- Data from the right and left foot were processed separately for each patient.
- Maximal moments of force were normalized according to body weight and height and were expressed as %Nm to take into account influence on muscle length and strength.
- The groups with diabetes were similar in duration (15 - 19 years) of the disease, hemoglobin A1c level (7.5% - 7.8%), and body mass index (25.3 - 27.0 kg/m^2).
- Mean age varied from 52.7 to 56.6 years for the 3 groups.
- There was an overall reduction in sagittal and transverse plane mobility, including dorsal and plantar flexion, in both groups of patients with diabetes vs control subjects, with significant reductions in all planes except plantar flexion in patients with diabetes without neuropathy.
- The reduction in ankle mobility was 11% and 20% in the sagittal and transverse planes, respectively, for patients without diabetic neuropathy vs control subjects.
- For those with diabetes and neuropathy, the relative reductions were 20% and 21% in the sagittal and transverse planes, respectively.

- There was a decreasing trend in muscle function in both diabetic groups, with both showing reduction in normalized moments of force in all planes, directions, and foot positions.
    - Internal rotation and eversion were reduced.
- There was a significant decrease in dorsal-flexing moments, with the greatest reductions of 28% in patients with diabetes without neuropathy and 37% in patients with diabetes with neuropathy vs control subjects.
- Plantar-flexing moments were reduced by up to 15% (range, 12% - 15%) for patients with diabetes without neuropathy and 24% (range, 10% - 24%) for patients with diabetes with neuropathy.
    - In all patients, the reductions in the frontal and transverse planes ranged from 14% to 41%.
- The authors concluded that the reduction in mobility and strength at the ankle for patients with diabetes was not accounted entirely by neuropathy because they also occurred in patients with diabetes without neuropathy.
- They proposed that muscle atrophy, metabolic, and other mechanisms may account for the altered foot-ankle biomechanics and that adequate gait performance may rely on prevention of excessive loading in patients with long-term diabetes.

Pearls for Practice

- Patients with diabetes, with and without neuropathy, demonstrate reduced foot and ankle mobility and strength.
- Reductions in mobility and muscle performance at the ankle in patients with diabetes are greater in patients with neuropathy vs patients with diabetes without neuropathy.