

## Forefoot Pressure During Gastrocnemius Stretching

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**Introduction:** Individuals with diabetes may develop gastrocnemius contractures and walk with ankle equinus. This ankle position is known to increase the magnitude and duration of forefoot pressure during gait, further amplifying the risk of ulceration. Stretching is often used as a conservative treatment in order to avoid surgical intervention to restore normal ankle motion. But the question has arisen of whether stretching itself subjects the forefoot to high pressures and if there is an alternate gastrocnemius stretching method that does not subject the forefoot to high pressures.

**Statement of Clinical Significance:** Quantifying the pressure dose during stretching methods is needed to understand the ulceration risks associated with conservative treatment of ankle equinus.

**Methods:** Eleven subjects free from orthopedic and metabolic disorders gave their informed consent to participate in this study. Subjects were fitted with identical shoes (extra-depth, PW Minor, Batavia, NY) and PEDAR insoles (Novel gmbh, Munich). Each subject performed two methods of calf muscle stretching: the first by placing their heel over the edge of a stair and holding their maximum stretch for 30 seconds and another by leaning against a wall while keeping their heel on the floor and maintaining maximum dorsiflexion. The subjects were instructed to keep their knee straight throughout both stretches and pick a position that they could hold for 30 seconds. Pressure data was sampled at 100 Hz for the duration of the stretch. During the stretch, dorsiflexion of the ankle was measured with a goniometer. Peak pressure and ankle angle were compared for the two stretches using repeated measures ANOVAs. Significance was set at 0.05 a priori.



Wall Stretch



Stair Stretch

**Results:** There was no significant difference in peak pressure for either stretch ( $p = 0.2833$ ) and no significant difference in dorsiflexion angle ( $p = 0.7840$ ). Peak pressure on the stair stretch was  $129.1 \pm 26.6$  Kpa and  $117 \pm 23.2$  Kpa for the wall stretch. These values are in agreement with other in-shoe pressure assessments<sup>1</sup>. The mean dorsiflexion angles for the stair and wall stretches were  $27.3^\circ \pm 5.5^\circ$  and  $28.1^\circ \pm 8.0^\circ$  respectively.

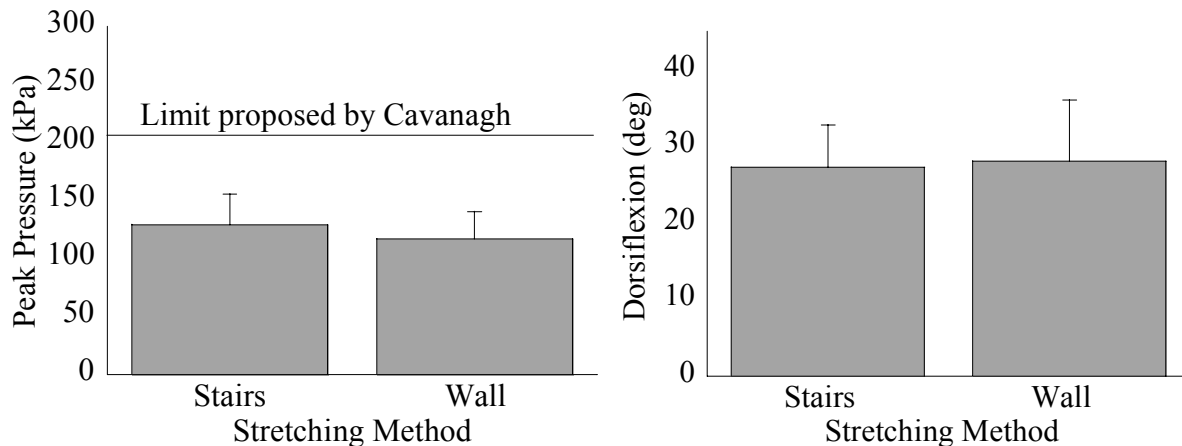


Figure 1. Peak pressure and ankle dorsiflexion while stretching. Significant differences were not detected in either measure.

**Discussion:** Neither stretch produced substantially high pressure levels compared to those during walking, and stayed well below the in-shoe pressure threshold of 200 kPa suggested by Cavanagh<sup>1</sup> to maintain ulceration healing. This suggests that stretching the calf muscles is not an activity which increases ulceration risk for individuals with equinus contractures. However, Cavanagh also points out that the pressure-time integral may be a more sensitive measure when evaluating ulceration risk<sup>1</sup>. Even low plantar pressures may increase the risk of ulceration if they persist for long periods.

The stair stretch was hypothesized to achieve an adequate stretch on the gastrocnemius while reducing the plantar pressures on the forefoot. However, the data showed no significant difference on the location of the center of pressure along the foot in the two stretches. However, the stair stretch may place more shear on the foot, which is not quantified by the in-shoe pressure sensors. The effect of shear on ulceration formation and healing is not known.

Individuals with diabetes may not be able to sense high plantar pressures due to peripheral neuropathy. However, studies have shown that reduced plantar sensation induced by ice in normals results in a decrease in peak plantar pressure during gait<sup>2,3</sup>, and did not increase as is seen in diabetic insensate feet<sup>1</sup>. Patients who are undergoing a stretching program require careful supervision and perhaps monitoring with in-shoe pressure measurement at intervals throughout the program to avoid deleterious pressure doses.

#### References:

1. Cavanagh, PR (2002) *Proceeding of the World Congress of Biomechanics, Calgary*.
2. Nurse, MA and Nigg, BM (2001) *Clinical Biomechanics* 16(9):719-27
3. Eils E, et al, (2002) *Journal of Biomechanics* 35(10):1307