Abstract

Shear stress in footwear is known to result in a higher average foot temperature, and in diabetic patients, this results in a high risk for foot-related injuries [1]. The current study aims to demonstrate that BOA shoe laces can reduce shear stress and, consequently, lower the average temperature of the foot. In order to test this hypothesis, 15 healthy patients were tasked with walking 200 steps in three trials, and infrared images were taken before and after every trial. Upon analysis, the images verify that the BOA technology did in fact reduce shear stress.

Introduction

- Patients with diabetes often have restricted blood circulation in their lower extremities, resulting in a high-risk environment during physical activity, which can lead to injury.
- Diabetic foot ulceration (DFU) is a common and largely preventable complication of diabetes. Shear stress is a precursor variable that can be measured and reduced through material means as a form of prevention [2,3].

Methods

- This study analyzed shear stress in the footwear of 15 patients. Subjects with debilitating or activity-impairing illnesses or diseases (e.g. diabetes, cancer) were excluded. Subjects were asked to walk 200 steps in three different trials in order to measure the difference in temperature between pre- and post-walk thermal images, and thereby the difference in shear stress.
- As a Proof of Concept, the first two trials tested loose-fitting and tight-fitting shoes against well-fitting shoes in order to prove that well-fitting shoes have a lower shear stress overall.
- The last trial tested the BOA technology on an well-fitting orthopedic shoe against a well-fitting regular shoe in order to show that the BOA technology vastly reduced shear stress in comparison to the regular shoe.

Findings

Figure 2: Depicted is the BOA technology. Patients were asked to walk 200 steps using the right shoe during the third trial of the study.

Figure 4: To assess shear force, a thermal imaging camera was used. Thermal pictures were captured pre and post 200 step-walk for all three trials in the experiment.

Figure 5: Data Analysis done with an original custom toolbox on MATLAB.

Figure 6: The table depicted shows the temperature difference in the pre-activity left shoe and post-activity left shoe (Optimal) and the pre-activity right shoe and the post-activity right shoe (Tested). The data is representative of the average of all tests.

Conclusions & Discussion

- Upon probability analysis, it is clear that this data is statistically significant (P < .005). The first set of data (Loose) yields P < .0001, the second set yields P < .007, and the third set yields P < .0001.
- Though tight shoes do in fact have a higher thermal response than well-fitting shoes, it is unclear as to whether or not this is the result of shear stress or restriction of blood flow, and calls for additional research.
- Continuation of research is necessary to analyze the extent of shear stress reduction induced by the BOA laces.

References

[1] Armstrong et al. 2007, American Journal of Medicine, Vo. 120 No. 12, 1042-1046

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Figure 1: Diabetic Foot Complications.

Figure 3: The table depicted shows the temperature difference in the pre-activity left shoe and post-activity left shoe (Optimal) and the pre-activity right shoe and the post-activity right shoe (Tested). The data is representative of the average of all tests.

Figures:

- Figure 1: Diabetic Foot Complications.
- Figure 2: Depicted is the BOA technology. Patients were asked to walk 200 steps using the right shoe during the third trial of the study.
- Figure 4: To assess shear force, a thermal imaging camera was used. Thermal pictures were captured pre and post 200 step-walk for all three trials in the experiment.
- Figure 5: Data Analysis done with an original custom toolbox on MATLAB.
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Thermal Response to Walking, Deg C

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<tbody>
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Data Analysis done with an original custom toolbox on MATLAB.