Plantar Pressures in Total Contact Casting Versus a Diabetic Walking Boot

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INTRODUCTION

Foot ulcerations represent one of the most important risk factors for lower extremity amputations in patients with diabetes mellitus. Peripheral neuropathy and increased dynamic foot pressures have been shown to be good predictors for an increased risk of foot ulceration1. In the United States alone, there are nearly 70,000 diabetes related lower extremity amputations performed annually. The US Department of Health and Human Services, as part of the Healthy People 2000 project, aims to reduce the incidence of lower extremity amputations by 40%2.

The goal of treatment for ulcerations in diabetic patients is to obtain a healed and closed wound that (1) eliminates a portal of entry for bacterial invasion and development of limb-threatening infection and (2) allows for offloading of tissues. The total contact cast (TCC) has been the gold standard for treating plantar foot ulcerations, which have been shown to heal in approximately 8 weeks3-5,. Other methods for reducing plantar pressures have been tried including the DH Pressure Relief Walker (Centec Orthopaedics, Camarillo, CA.) and the Aircast Pneumatic Walker (Aircast, Summit, NJ). A study in 1997 concluded that the pneumatic walker was as effective as a total contact cast in reducing peak plantar pressures6. However, the authors only measured plantar pressures in five distinct locations under the foot using pressure sensors that were not meant for accurate quantitative measurements. In 1999, Armstrong et al. compared TCCs against the DH Pressure Relief Walker and the Aircast Pneumatic Walker, and found that the TCC reduced pressure significantly better than the other two modalities7.

A new walking boot, the Bledsoe Conformer Diabetic Boot (Bledsoe Brace Systems, Grand Prairie, TX) was specifically designed for the diabetic patients with problematic ulcerations. The Bledsoe Conformer Diabetic Boot features a fully enclosed thick foam cocoon attached to an auto molding innersole that embeds into a specially designed pre-molded mid-sole insert in an aluminum shelled walking boot. The objective of this study was to determine in healthy individuals whether the Bledsoe Conformer Diabetic Boot reduces plantar pressures as well as or better than a total contact cast.

METHODS

Ten normal subjects, without any prior foot or ankle problems, were recruited for this study. There were 2 female and 8 males, with an average weight of 86 kg and an average height of 178.5 cm. Plantar pressures were measured using the Novel Pedar in-shoe pressure measurement system (Novel, Düsseldorf, Germany). Data were collected at 50Hz using 2-mm thick capacitance insoles with 99 sensors per insole. Each insole also had an approximate sensor resolution of 1 sensor/cm2, dependent on the insole size.

The pressure maps of each insole were divided into five regions called masks: heel, lateral midfoot, medial midfoot, lateral forefoot and medial forefoot. Peak plantar pressure, maximum plantar force, average plantar pressure, plantar contact area, plantar contact time and pressure time integral were analyzed in each foot and in all foot regions defined by the masks.

Each subject was asked to walk with the Bledsoe Conformer Diabetic Boot and a total contact cast. The total contact casts were all administered by the same casting technician using the same techniques applied in our clinic. The subjects were randomly assigned to the order of testing for the two conditions. For each condition, the subject was asked to walk at a self-selected speed down a 10-meter walkway several times. Approximately 15 steps for each condition were used for averaging and further statistical analysis.

Statistically, paired t-tests were used to compare between the total contact cast results and the boot results. An alpha level of 0.05 was used for all statistical tests.

RESULTS

The contact times (walking velocity) in the total contact cast and boot were no different. The total contact area was slightly increased in the cast as compared to the boot by 6%, but this was not statistically significant. The maximum force was reduced in the boot as compared to the cast under the lateral portion of the midfoot by 53% and lateral portion of the forefoot by 23%. The maximum mean pressure was also significantly reduced under the lateral portion of the midfoot from 4.6 N/cm2 in the cast to 2.6 N/cm2 in the boot.

The peak pressure was significantly reduced in the boot as compared to the cast in all five regions as well as the combined total measured region (see Figure 1).

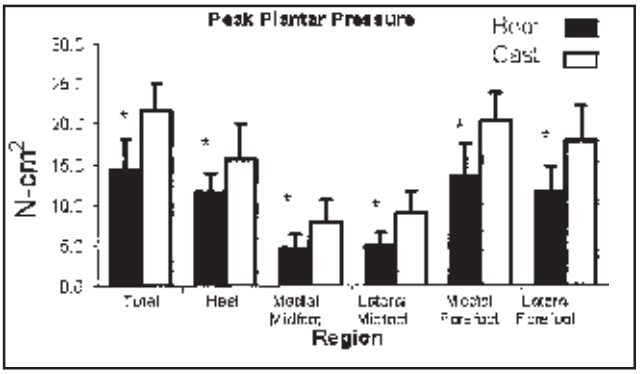

Figure 1

The total peak plantar pressure was reduced on average by one-third in the boot as compared to the cast. Pressure time integrals were also significantly reduced in the boot as compared to the cast under the total foot by 23% and under the lateral portion of the forefoot by 23%.

DISCUSSION

The results of this study demonstrate that in healthy individuals, the Bledsoe Conformer Diabetic Boot performs as well, and in some cases even better, than a total contact cast in regards to reducing the force and pressure on the plantar surface of the foot. In addition, the peak pressures were reduced even though the contact area was slightly greater in the total contact cast. These boots seem to more evenly distribute the force over plantar surface of the foot, while also providing some side loading which reduces the overall load on the plantar surface of the foot.

Therefore, for assistance in healing ulcers on the plantar surface of the foot, the Bledsoe Conformer Diabetic Boot should work as well or even better than a standard total contact cast with the added convenience of allowing for the removal of the boot for cleaning the wound periodically. Studies are underway which will investigate these pressure differences in diabetic patients, while also examining clinical data with regards to ulcer healing time.

REFERENCES

1. Young et al., Diabet Med (9):55-7, 1992.
2. Healthy People 2000 (DHSS pub no 91-50213). p73-177, 1991.
3. Sinacore et al., Phys Ther (67):1543-9, 1987
4. Myerson et al., J Bone Joint Surg (74A):261-9,1992,
5. Caputo et al., Am Fam Phys (55):605-11, 1997.
6. Baumhauer et al., Foot Anklr Int 18(1):26-33, 1997.
7. Armstrong et al., J Am Pod Med Ass 89(1):50-3, 1999.

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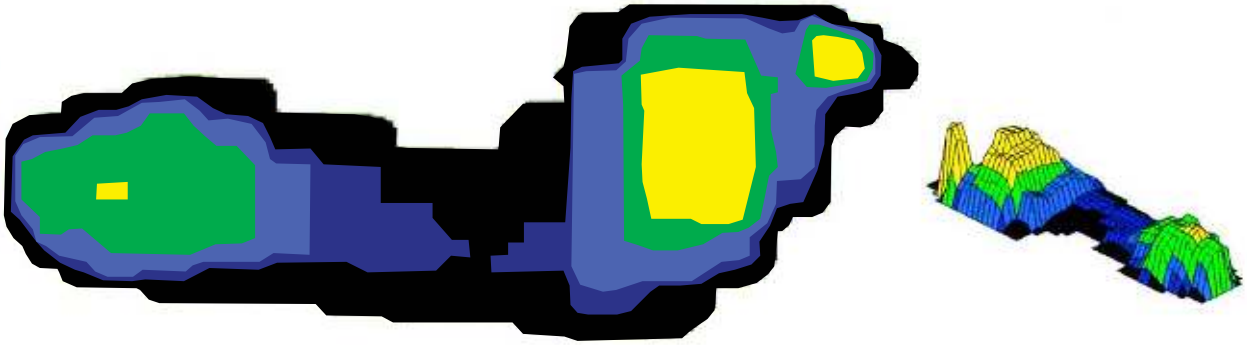
Patient Sample using the Pedar System

2 Dimensional

3 Dimensional

Conformer

TCC



Shoe