KINEMATIC ANALYSIS OF TIBIAL POSITION RELATED TO PEAK PLANTAR PRESSURE INSIDE OFFLOADING SYSTEMS

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Statement of Purpose

- From managing ulcers to post-operative weight bearing, various offloading devices are routinely used by the foot and ankle surgeon. These devices aim to keep plantar pressure at a minimum to assist with wound healing; similarly, research shows that maintaining the tibial angle (TA) close to 90 degrees further reduces forefoot peak plantar pressure (PPP).
- The purpose of this study was to compare the PPP and TA at the PPP of offloading devices. The results of this study emphasize the importance of selecting the appropriate offloading device.
- 4 methods of offloading were compared: 1) Diabetic Shoes 2) Total contact cast (TCC)with honeycomb roll-up cast and rigid boot (Honeycomb TCC) 3) TCC with walking heel (TCC W/ walking heel) and 4) traditional fiberglass TCC (TD TCC).

Methods

- Recruitment flyers for castees was distributed around Barry university's main campus.
- During the screening, the investigators explained the study and answered questions the participants would have.
- 15 Healthy subjects, ages 18-28, were selected.
- Participants were asked to sign an informed consent forms which will be kept in a locked file cabinet and stored separately from the working records regarding data collection
- Names of all participants will be replaced with a numerical coding system.
- Data collections was done in the MAC-lab on the university main campus.
- Casts applied according to manufacturers instructions, with specific emphasis in 90 degrees and the diabetic shoes were already sized for each castee.
- Wireless pressure mapping sensors were calibrated and used to measure the plantar surface peak forefoot pressure.
- Castees had the sensors and each of the offloading devices applied to one leg only, and reflective markers will be placed on their lower extremities.
- Kinematic data was recorded with a 3D motion analysis system (3D MAS) to analyze and measure tibial position.
- Sixteen reflective markers was placed on the participants' right and left (R/L) anterior and posterior superior iliac spines, each thigh, knee, tibia, lateral malleoli, heel, and distal ends of both second metatarsals.
- The 3D MAS used 7 cameras, operating at a sampling frequency of 240 Hz to measure tibial position by using the knee joint, lateral malleolus and the lateral column of the foot as landmarks to find the relative angle.
- The participants were instructed to walk at 2.8 mph on a treadmill for three minutes. Plantar pressures will be measured and recorded.
- Repeated Measures ANOVA's was conducted for each dependent variable.

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Literature Review

- Elevated peak plantar pressure (PPP) has long been associated with development of foot ulcers in diabetic patients with peripheral neuropathy (Bus, 2012).
- Reducing PPP through offloading is one of the main goals of preventing and help healing diabetic foot ulcers. (Boulton 2008).
- Several different casting techniques are used to reduce these PPP (Bus, 2012).
- Research recommends to keep the tibial angle close to 90 degrees in the casts to maintain the reduced forefoot plantar pressure (Burns & Begg, 2011).
- It is still unclear if the uses of different offloading devices is effective in decreasing forefoot plantar pressure and also keeping the tibial angle at 90 degrees (Wrobel, 2010).
- The PPP and tibial angle at PPP in casting techniques are variables effecting healing of wounds on the plantar aspect of the foot. (Burns & Begg, 2011).

Results

- The repeated measures ANOVA found significant differences between the casts and the Diabetic Shoe. Paired – samples t-tests revealed that all 3 casting techniques significantly reduced PPP as compared to the Diabetic shoe. There was no significant differences in PPP between the three Total contact casts.
- The samples t-tests also revealed that the honeycomb TCC cast with rigid boot and the Traditional TCC had significantly lower Tibial Angle at PPP. There were no significant differences in Tibial Angle at PPP between the TCC with walking plate and Diabetic Shoe.

Peak Forefoot Plantar Pressure and Tibial Angle in the 3 Casting Technique

	Peak Plantar Pressure (N/cm3) Mean (SD)	Tibial Angle (degrees) Mean (SD)
Diabetic shoe	589.89 (317.15)*	110.17 (9.03)
TCC with honeycomb roll-up cast and rigid boot	385.07 (161.91)	93.63 (5.56)[1]
TCC with walking heel	359.93 (276.47)	105.31 (10.65)
Traditional fiberglass TCC	299.03 (173.85)	98.90 (9.09)[1]

Note: Tibial angles measured in the sagittal plane
*Significantly different from all 3 casting techniques ($p<0.05$)
[1] = Significantly different ($p<0.05$)

Results

Figure 1: Mean Tibial Angle (Degrees) in diabetic shoe, TCC with walking boot, Traditional TCC and Honeycomb TCC

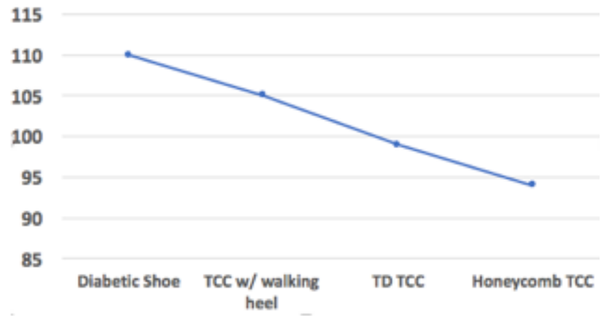
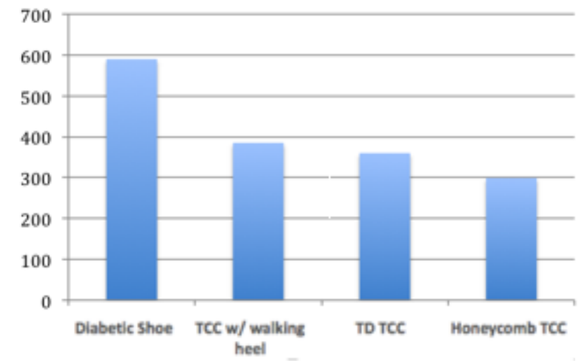


Figure 2: Mean Peak plantar pressure in diabetic shoe compared to honeycomb TCC, TCC with walking heel and traditional TCC



Discussion

Clinically the goal is to maximize offloading after applying grafts or dealing with wounds to increase the speed of healing. We found that each casting method reduces peak forefoot plantar pressure. We also found that there was great variability in Tibial Angle at PPP, which could be associated with issues in cast application and cast design . As a result of these limitations we would propose future research that would focus on the influence of duration of peak pressure due to differences in Cast design and application.

References

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