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Short Communication

Residual limb temperature study with Pe-Lite liner in traumatic transtibial amputees

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ABSTRACT

Interventions to alleviate thermal discomfort, a common complaint in amputees, are typically chosen based on residual limb skin temperature while wearing prosthesis; however, residual limb skin temperature while outside of the prosthesis has received less attention. The purpose of this study was to investigate the localized and regional skin temperature over the transtibial residual limb (TRL) when the prosthesis was removed. The present study documents the temperature variations in a traumatic below knee amputee with Pe-Lite liner. This study included eight unilateral transtibial amputees. Over the residual limb, twelve sites were marked in four columns (anterior, posterior, medial, and lateral) and three rows (proximal, middle, and distal). The temperature of the residual limb was measured with an infrared thermometer both in a relaxed state and after 30 minutes of activity with a Pe-Lite liner. The current study found a rise in temperature on the anterior side (36.30ºC to 36.44ºC), posterior side (36.36ºC to 36.50ºC), medial side (36.34ºC to 36.40ºC), and lateral side (36.35ºC to 36.45ºC). The temperature distribution over the TRL was found to be unequal, with significantly higher and lower temperatures on its posterior and medial sides, respectively.

Keywords: Residual limb, Temperature, Pe-lite liner, Traumatic amputation, Transtibial amputee

INTRODUCTION

More than half of prosthesis wearers will experience overheating, excessive sweating, and thermal discomfort as a result of their prosthesis. Amputees are more prone to overheating and hyperhidrosis because their thermoregulatory responses are less effective due to their reduced body surface area.[1]

The skin integrity of the residual limb, as well as its health and hygiene, are important factors in the successful use of prosthesis. Skin irritation, ulceration, dermatitis, and excessive sweating are all common complaints among amputees who use prostheses on a daily basis. Heat and moisture trapped inside the socket create a dangerous, unpleasant, and infectious environment for amputees, reducing their quality of life, satisfaction and use of the prosthesis and social participation.[2-7]

To avoid skin problems and discomfort while using the prosthesis for daily activities, prosthetic users required a comfortable liner and a good socket. The liners' cushioning effect reduces peak pressure and shear forces between the socket and residuum, preventing skin breakdown. Lower limb amputees are frequently prescribed prosthetic liners to make the prosthetic socket more comfortable. There are a variety of liners available on the market for transtibial amputees. Since 1950, clinicians have used Pe-Lite foam liner. Pe-Lite is a type

of expanded cross-linked sponge foam that is shaped to fit inside the socket to provide cushioning. Suprapatellar strap or cuff or supracondylar bulge or suspension sleeve worn over the socket and extending to mid-thigh are some of the strategies used to achieve a variety of suspension with Pe-Lite liner.[8-11] Because common liner and socket materials have low thermal conductivity, they effectively insulate the residual limb. Improving the thermal properties of socket and liner materials can increase amputee comfort and promote a healthier limb environment.[12]

Lower-limb amputees frequently complain that uncomfortably warm residual-limb skin temperatures reduce their quality of life. A temperature increases of 1.7 degrees Celsius may be enough to cause this discomfort. Elevated skin temperatures can influence amputees' perceptions of comfort and may be linked to the occurrence of residual-limb skin injuries. Hagberg and Branemark discovered that heat and perspiration inside the prosthetic socket were the most common causes of lower-limb amputees reporting a reduced quality of life in a survey of 90 lower-limb amputees (72%). Heat buildup and an accompanying rise in skin temperature may increase the risk of skin problems, according to evidence that suggests blisters form more quickly in warm and moist conditions. Unfortunately, the closed environment of the residual limb and socket system creates both warm and moist conditions for amputees. Understanding the thermal environment is the first step in developing new approaches to prosthetic socket systems that could resolve these problems for amputees who experience temperature-related discomfort and an increased risk of skin problems.[13,14]

Unfortunately, little is known about stump skin temperatures inside prosthetic liner systems or the differences between them. It has been demonstrated that donning causes a moderate temperature increase, walking causes a significant increase, and rest periods following activities must be significantly longer to return the limb to resting state temperatures.[7]

Researchers have known for a long time that many lower-limb amputees find their prosthetic sockets to be uncomfortably warm. In addition to being uncomfortable, this warm and moist environment may increase the occurrence of residual limb skin problems.[13]

As a result, the current study aimed to describe surface temperature distribution by measuring TRL skin temperature while prosthesis was removed.

METHOD

Selection of subjects

This cross-sectional study was carried out at the Endolite clinic in Chennai from August 2021 to July 2022 after getting approval from the institutional ethical committee. Table 1 show the descriptive information for a convenience sample of 8 subjects who voluntarily participated in the study. Six of the eight subjects chosen based on inclusion criteria were male, and two were female, with a mean age of 37.37±7.42 years.

Inclusion criteria

Subjects between the ages of 25 and 45, with traumatic amputation, unilateral transtibial amputation, and at least 2 years of experience with prosthesis use were included in study.

Exclusion criteria

Existence of any medical comorbidities that may alter sensation, cardiovascular and endocrine, alcohol drinking, smoking, fever, impaired thermal sense in the residual limb were excluded.

Procedure

The subjects were invited to take part in the study. According to the inclusion criteria, the subjects were evaluated and screened. The procedure was thoroughly explained to the subjects. Subjects who agreed to participate in the study signed the consent form. Participants sat in a chair for 30 minutes to rest while their prosthesis was removed. Over the residual limb, twelve sites were marked in four columns (anterior, posterior, medial, and lateral) and three rows (proximal, middle, and distal). The temperature of the residual limb was measured with an infrared thermometer both in a relaxed state and after 30 minutes of activity with a Pe-Lite liner.

Statistical technique

The data was analysed using the statistical package for social sciences (SPSS) 21 version. To determine the difference between pre and post temperature readings, the paired t-test was used.

RESULT

This study included 8 unilateral transtibial amputees who met the eligibility criteria. Table 1 shows the descriptive statistics for the demographic data. It displays descriptive data such as mean age, height, weight, and BMI. The mean and SD value age of the entire population was 37.37±7.42, the mean and SD value of height was 170.87±10.8, the mean and SD value of weight was 74.87±14.4, and the mean and SD value of BMI was 25.52±3.59. Table 2 summarizes the clinical characteristics.

Temperature measurement over the TRL

The temperature of the residual limb was measured with an infrared thermometer (Figure 1) in a relaxed state and

after 30 minutes of activity with a Pe-Lite liner. The mean value was calculated by averaging the three values from each row (proximal, middle, and distal), on each side (anterior, posterior, medial, and lateral) for each measurement. Table 3 and Figure 1 show the mean and standard deviation of the skin temperature recorded by the infrared thermometer on each side.

Temperature was found to be significantly different ($p<0.05$) using paired sample t tests. There was an increase in temperature on the anterior side (mean SD=36.30±0.087 to 36.44±0.107, p=0.000), the posterior side (mean SD=36.36±0.106 to 36.50±0.094, p=0.000), the medial side (mean SD=36.34±0.093 to 36.40±0.07, p=0.000), and the lateral side (mean SD=36.35±0.103 to 36.45±0.101, p=0.000) (Table 3).

Figure 2 shows that there was rising in temperature after 30 minutes of walking with Pe-Lite liner.

Table 1: Descriptive data of mean (Age, height, weight and BMI).

Subjects' characteristics	N	Mean±SD
Age (years)	8	37.37±7.42
Height	8	170.87±10.8
Weight	8	74.87±14.4
BMI	8	25.52±3.59

*Significant at 0.05 level Values are represented as mean±SD, Age: years, Height: cm, Weight: kg, BMI: kg\m ²

Table 2: Clinical data of subjects.

Clinical characteristics	N	Mean±SD
Time after amputation	8	6.50±2.43
Years of prosthesis use	8	4.62±2.19
Daily prosthesis use	8	7.75±2.81
Employment status	8	1.37±0.51
Amputation side	8	1.25±0.46

*Significant at 0.05 level, Temperature is in Celsius.

Figure 1: While taking temperature reading.

Table 3: Temperature reading before and after an activity of walking.

Sides of residual limb	Without activity, (Mean±SD)		After activity, (Mean±SD)	T value	P value
Anterior	36.30±0.087	**30 minutes of walking with Pe-Lite liner**	36.44±0.107	4.53	0.003
Posterior	36.36±0.106		36.50±0.094	5.40	0.001
Medial	36.34±0.093		36.40±0.07	1.30	0.233
Lateral	36.35±0.103		36.45±0.101	4.55	0.003

*Significant at 0.05 level.

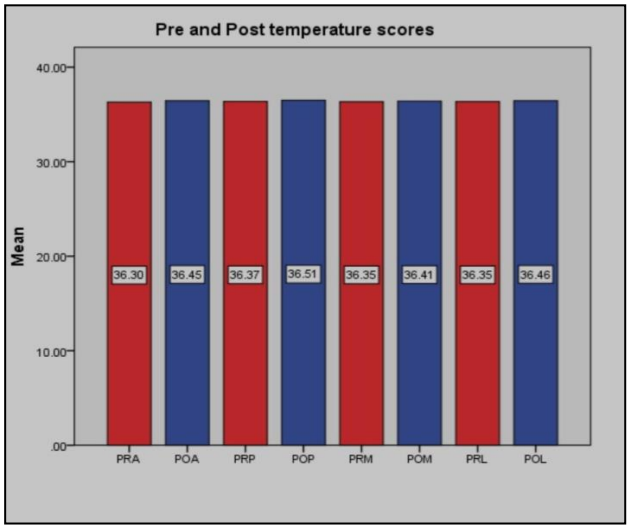

Figure 2: Comparison of temperatures.

The study's goal was to record temperature changes in a traumatic below-knee amputee using a Pe-Lite liner.

The data analysis revealed that temperature measurements on all sides of the residual limb differed significantly. The current study found that temperature rose on the anterior side (36.30ºC to 36.44ºC), posterior side (36.36 ºC to 36.50ºC), medial side (36.34ºC to 36.40ºC), and lateral side (36.35ºC to 36.45ºC), but the highest and lowest skin temperatures were found on the posterior and medial sides of TRL, respectively.

The skin temperature of the TRL was determined to be 27.7±0.8°C on average, ranging from 27 to 31°C, according to Ghoseiri et al. The TRL's recorded average temperatures were 29.1±0.6°C, 29.5±0.9°C, 31±1.5°C, and 31.4±1.3°C, respectively. These differences could be attributed to differences in study designs and data collection methods. Because of the reduced surface area

of the body and changes in blood circulation, as well as the volume and shape of the residual muscles, the residual limb skin temperature is generally higher in amputees than in non-amputees. Peery et al measured skin temperature in five TRLs and found that the proximal anterior region of the residual limb was the coldest and the posterior region was the warmest.[13,15,16]

Klute et al investigated residual limb skin temperature in nine transtibial amputees and discovered that skin over the tibialis anterior, i.e. the anterolateral location of the residual limb, at the middle level between the proximal and distal ends, had the warmest temperature, while skin over the tibialis posterior, i.e. the posteromedial location at the distal level of the residual limb, had the coldest temperature.[6]

Ghoseiri and colleagues measured residual limb skin temperature in a single transtibial amputee and discovered that the middle part of the TRL's anterolateral region had the highest skin temperature, while the distal part of the residual limb's posterior region had the lowest skin temperature.[15]

As a result, despite some common findings regarding the TRL's warmest and coldest regions, there is no general consensus, indicating the need for additional research.

Coleman et al and Boonstra et al found Pe-Lite liner to be more beneficial. Patients overwhelmingly preferred the Pe-Lite and took 82% more steps with that system, according to the study's findings. More cost-benefit analyses could assist clinicians in prescribing devices that provide maximum function at the lowest possible cost, potentially saving the healthcare system a significant amount of money.[8,17,18]

CONCLUSION

This study could help researchers develop thermoregulatory strategies for transtibial amputees' residual limbs. Outside of the prosthetic socket, the TRL had unequal skin temperature distribution. The highest and lowest skin temperatures were measured on the posterior and medial sides of TRL, respectively. Further research into residual limb temperature should be conducted, taking into account the relationship between demographic and clinical characteristics.

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