# How Does Elevated Vacuum Suspension Provided by The LimbLogic Impact Limb Tissue Health

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# Background

Elevated vacuum suspension (EVS) was first introduced to the prosthetic field in 1995[1] and became commercially available in 1999[2]. EVS suspension continues to grow in popularity on the basis of improved fit and function[3-6] through a reduction of pistoning[3,7-9] and residual-limb volume management[3,10-11]. Even more interesting are the reports of wound healing when using an EVS prosthesis[6]. WillowWood and The Ohio State University partnered on a study to better understand what limb health changes are occurring to explain these wound healing events.

# Methods

Ten lower extremity amputees (five transtibial and five transfemoral) participated in the randomized crossover study. Participants wore a non-EVS or EVS prosthesis for 16-weeks before switching to the other condition. Measurements were taken and the beginning and end of the 16 week period. Transepidermal water loss was used to quantify skin barrier function. Hyperspectral imaging was taken before and after a 10-minute walking activity at each visit and measured oxygen within the skin tissues. Transcutaneous oxygen measurement measured the amount of oxygen present within the skin tissues during activity.

# Results

The results[12] identified improved skin barrier function, increased oxygen level in the skin tissue during walking, and less reactive hyperemia following socket doffing when EVS was used compared to non-vacuum suspension (Figure 1). Oxygen levels while during activity were restored to a critical level of 40 mmHg after long term EVS use (Figure 3). This improvement in oxygen levels during activity would lead to a reduction in reactive hyperemia (Figure 2) and therefore promote skin barrier function (Figure 1).

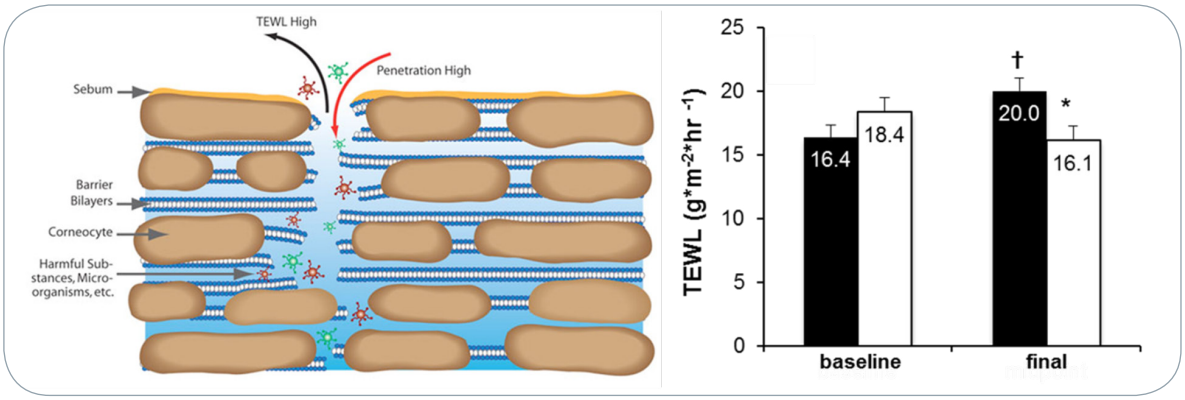


*Figure 1: Transepidermal water loss measures how well your skin is regulating interactions with the environment. While some water loss is normal, high levels of TEWL indicate a disruption of skin barrier function. If water is leaving at a high rate, bacteria can also penetrate at a higher rate. With EVS use, we found improvements in TEWL.*

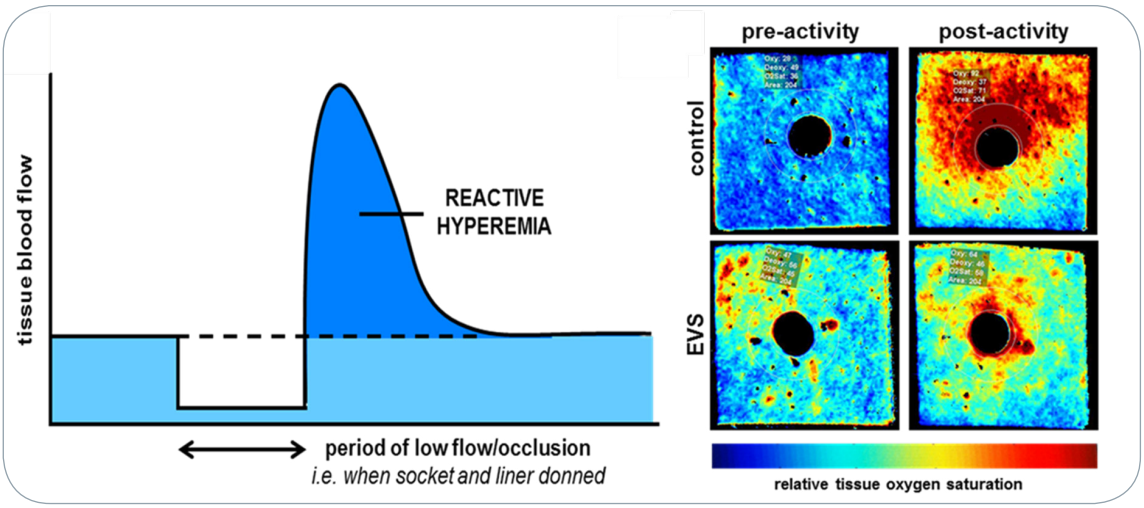


*Figure 2: Reactive hyperemia is your body's natural response to a period of limited blood flow. Generally it is a favorable response because your body is restoring balance but with prosthesis use it is a negative response because it indicates wearing the prosthesis is occlusive to blood flow. With EVS use, we found a reduction in reactive hyperemia.*

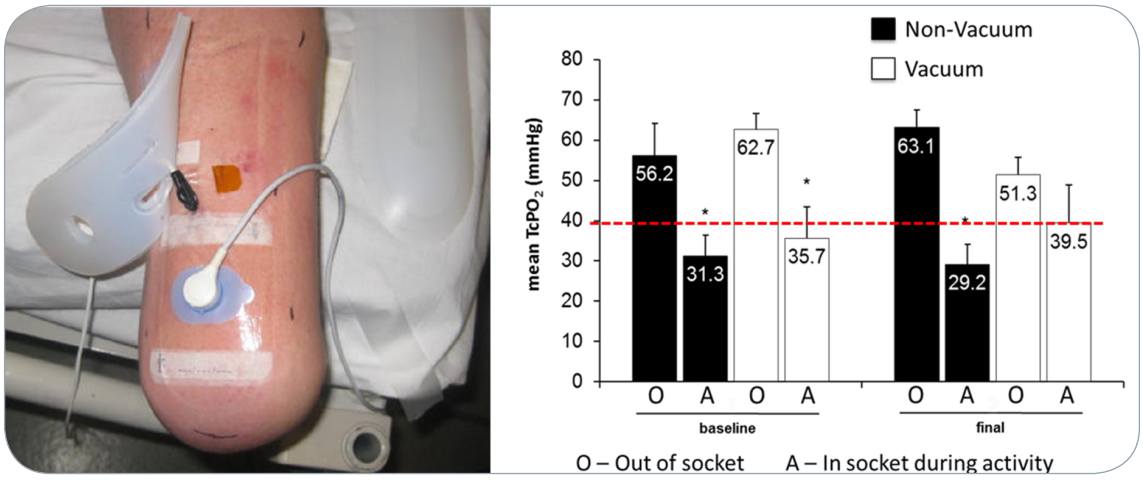


*Figure 3: Measurement taken during activity found that EVS restored oxygen levels to a critical level of 40 mmHg (red line), below which there is not a proper nutrient delivery to the skin tissues. Better blood flow inside the socket would lead to a reaction of reactive hyperemia (Figure 2) and therefore better skin tissue health (Figure 1).*

## Conclusion

Together these results show that long term use of elevated vacuum suspension improved the objective skin outcomes. The authors suggest this is due to EVS providing a more stable limb environment through a reduction of socket motion[3,7-9] and more stable limb volume[3,10-11] that has been reported in the literature. Lower socket motion and more stable fit will reduce stress applied to the soft tissues of the limb allowing the limb to adapt over time, leading to the improved skin health.

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