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Effect of Mechanical Interaction between Clothing and Body on Skin Blood Flow

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Abstract

The mechanical interaction between the human body and foundation wear, which consists of normal load (pressure) and tangential load (shear), has a complicated influence on human physiological activities. In this study, five female subjects were asked to lay supine still, pressure loads of 20 mmHg and 40 mmHg and two levels of shear loads were exerted on the shank respectively, and the blood flow of skin undergoing loading was measured by using Advance Laser Blood Flowmeter. The results obtained were as follows: the low pressure could promote the skin blood flow; the shear load was effective in reducing the skin blood flow; little shear added to the pressure had important role on reducing the skin blood flow.

Keywords: Foundation Wear; Pressure; Shear; Skin Blood Flow

1 Introduction

As foundation wear helping to shape human figure for beauty becomes popular, the safety and comfort of such tight wear should be paid more attention in clothing design. The mechanical interaction between the human body and tight wear has a complicated influence on many human physiological activities. It has been reported that the mechanical force caused by tight garments can affect the heart beat, respiration, blood pressure, skin temperature, skin blood flow, and even autonomic nervous system both positively and negatively [1, 2].

As the skin is the first layer under loads, the embedded microcirculation system must be affected. It is known that the mechanical force consists of normal load (pressure) and tangential load (shear). Much attention has been paid to that pressure could affect blood microcirculation in skin. It was reported that the capillaries could be squashed and skin blood flow (SBF) may decrease when the magnitude of pressure is higher than 35 mmHg [3]. The skin may ulcerate because of the SBF decrease and nutrient deficiency, if it is under pressure for a long time. Since the human body is soft and flexible, the shear exists and deforms the skin and soft tissue easily as women wearing foundation wear, and it also has great physiological effect on the skin. Early in

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1958, Reichel proposed that shear is an important factor among other mechanical forces and its effect on soft tissue should not be ignored [4]. Zhang analyzed the mechanical mechanism of shear forces and found that the application of surface shear forces alters the internal stress distribution [5]. Some researchers investigated the etiological role of shear forces in decubitus ulcer. However, the effect of shear loads on skin microcirculation has seldom been reported, and the mechanism also needs to be discovered.

In this study, the change of skin blood flow was investigated when pressure, shear loads and the combined loads were applied on the lower limb respectively, and the mechanism of how the pressure and shear loads affect the skin blood flow is also discussed.

2 Methods

2.1 Subjects

Five healthy female undergraduates participated in this study. They were denoted as S1-S5 respectively. Their physical data (mean ± standard deviation) were as follows: age 20±1 yrs, height 163±3 cm, and weight 50±3 kg. The subjects had refrained from heavy exercise, salty food, alcohol and caffeine for 24 hours before measurement. To avoid the influence of climate change on SBF, the experiments were carried out in a climate chamber with constant temperature (20±2 °C), relative humidity (45±5%) and air velocity less than 0.1 m/s. The subjects were asked to rest for at least 30 minutes to reach a stable resting state before the tests began.

2.2 Loading Protocol

Two levels of pressure (20 mmHg and 40 mmHg) were exerted on the shank, with subjects lying still, by using the sphygmomanometer (Fig. 1 (a)). The shear loads were produced by pulling upward the tape adhered to the front surface of the shank (Fig. 1 (b)). The displacement of the tape top indicated the level of shear loads, and two levels, shear1 (6 mm) and shear2 (10 mm) were employed. Each level of load (pressure and shear) was exerted on and off for three times, and the interval was two minutes. The combined load pressure and shear was exerted: after a two-mins measurement of SBF under no load, the pressure was exerted on the shank for two minutes, and then the shear was added to the pressure load for the third two-mins. Pulling the tape under pressure was difficult, and the little shear (4 mm) was chosen, being noted as shear0. Shear0 was added to 20 mmHg and 40 mmHg respectively.

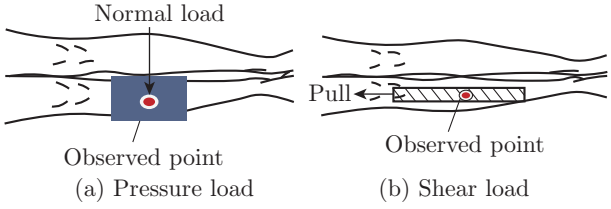

Fig. 1: Loading protocols