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Clothing Pressure Gradient for Comfortable Pantyhose ⋆

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Abstract

Our aim is to develop a pantyhose that fit without being too tight and to reduce muscle fatigue. This study was conducted with 17 Japanese women who wore two types of pantyhose with a structural difference in the panty part. When wearing pantyhose with a clothing pressure that gradually increased from 2.9 hPa in the waist to 11.0 hPa in the foot, participants reported a nearly perfect pressure sensation using a ratio scale. Thus, pantyhose with an optimized pressure sensation can be created according to the clothing pressure gradient rule. When participants wore pantyhose, EMG changes in the lower leg significantly restricted muscle activity when compared to that in the barefoot condition, that was clarified the local distribution of pressure intensity determines the intensity of muscle activity.

Keywords: Japanese Women; Pantyhose; Clothing Pressure; Pressure Sensation; Electromyogram

1 Introduction

Wearing high heels can make the wearer appear taller, which results in a slimming effect on the appearance of the legs. However, compared with being barefoot, wearing high heels is thought to put more strain on the lower legs [1-6]. Pantyhose makes the appearance of bare skin beautiful [7] and pantyhose is often worn with pumps and exerts cosmetic effects [8], such as raising the hip line and causing the legs to appear longer. In order to create a more comfortable pantyhose, Dan et al. calculated the compression rate of the abdomen during wearing and attempted to provide useful information for manufacturing comfortable pantyhose [9]. When actually wearing legwear, Liu et al. stated that the difference in skin pressure of the four stages affects core body temperature and skin temperature. High skin pressure (moderate level: 25.1-32.1 mmHg, strong level: 36.4-46.5 mmHg at the ankle) due to compression legwear increasing skin temperature and core temperature transiently, but both significantly decrease with long-term wear. In other words, it had a negative impact on the human body. However, when wearing compression legwear, the light and mild level skin pressure (10-14 mmHg, 18.4-21.2 mmHg in that order) decreased the leg

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fatigue feeling and maintained a comfortable wearing sensation after wearing for 180 min [10]. Nakahashi et al. used pantyhose to apply a high pressure of about 3-5 kPa only to the calf part but compared to the control of 1 kPa or less, the support-type pantyhose stated that the heart rate and core temperature decreased [11]. In this way, we thought that a pantyhose pressure design that could be completed within a physiologically comfortable pressure range for humans was necessary. Therefore, the purpose of this paper is to clarify the allowable pressure when wearing pantyhose and to clarify the pressure distribution when pantyhose is made.

Heavy clothing pressure leads Wearers typically expect pantyhose to fit well but not too tightly, and for the pantyhose to reduce fatigue on the legs and hips when wearing heeled shoes. Thus, the goal of this research study was to develop pantyhose that can reduce leg muscle fatigue [12] when wearing heels. In more specific terms, to develop a product that reduces muscle activity in the lower limbs and provides a comfortable wearing sensation when worn for many hours daily. Therefore, the relationship between clothing pressure and pressure sensation while wearing pantyhose was investigated changes in the muscle activity with and without pantyhose were examined [13].

2 Experimental Methods

2.1 Design and Composition of Experimental Pantyhose

Two types of pantyhose were examined in this study, namely size M and L. Japanese women of 88% can be covered by the JIS standards with S, M and L (Their heights were about 150 cm, 158 cm and 166 cm) sizes. The pantyhose used in this study were sized to fit M and L size people; their height was 159.5 ± 6.1 cm, and their weight was 50.3 ± 3.3 kg (See 3.2 as follows). The material and knitting structures of two experimental pantyhose are shown in Table 1. The pantyhose was composed of a single covered yarn (SCY) composed of 20D (2.2 tex) polyurethane/12D (1.3 tex) nylon in the legs. In the panty part, the thickness of the nylon yarn was changed from 12D (1.3 tex) to 30D (3.3 tex), and woolly nylon yarn was added to increase the strength (pantyhose A). Using the design of pantyhose A as a baseline, the SCY was partially doubled in pantyhose B to change the supporting pressure of the panty part. The clothing pressure gradient design of the panty part of the pantyhose in this experiment applied the material properties and pressure distribution of half pants reported in 2016 [10]. In addition, the design of the pressure gradient from the toes to the waist was designed based on the preferred clothing pressure balance of the whole body reported by Mitsuno and Kai in 2018 [15]. However, the result of the report was the preferred pressure when using a single elastic band to compress only one plane of the body part simultaneously. It is known, when the surface area of the body compressed at the same time increases, the pressure value evaluated as just right decreases [16]. That is, the covered area increases, and the pressure sensation saturates with a smaller pressure value, then we tried to configure the pantyhose to cover the entire lower half of the body, with a smaller pressure value than reported in 2018 while maintaining the balance of the pressure gradient. This is designed to reduce excess movement around the knees and distribute the load on the lower back [13]. The basic knitting structure of the pantyhose comprised of plane stiches, and the section of fabric with partial supporting pressure consisted of single-rib stitches.

The measuring system for sample materials' tensile force and strain is shown in the left Fig. 1 and the right figure is shown the measuring area of experimental pantyhose. The tensile force