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Possibility of Pantyhose Design using Clothing Pressure and Myoelectric Potential as Indices

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Abstract

This paper reports a study of 13 Japanese women who wore two types of pantyhose that were rated as providing an "almost-perfect pressure sensation" and three types of shoes. The root mean square of the electromyogram for eight muscles in the right leg was calculated. RMS has divided four group muscles: into each muscle around the knee, around the knee, on the ventral side, and on the dorsal side, and investigated how it changes between bare feet, pantyhose, and shoes. Each pantyhose is designed to stretch the legs well and follow the walking motion easily, but pantyhose B is double woven from the abdomen to the backside so as to connect to the back side while lifting the subcutaneous fat of the abdomen. Even if the pantyhose is made to apply almost the same pressure to the ankles, changing the design of the panty part can activate or suppress abdominal muscle activity.

Keywords: Pantyhose; Electromyogram; High-heeled Shoes; Clothing Pressure; Pressure Sensation; Japanese Women

1 Introduction

Many women wear high-heeled shoes to make their legs look slenderer and more beautiful, and to appear taller. Wearing high-heeled shoes puts more physical strain on the lower legs and hips than when barefoot [1-6]. Pantyhose is often worn with heeled shoes, to enhance the appearance of bare skin [7,8] and to exert a body-shaping effect by raising the hip line, causing the legs to appear longer. Wearers prefer pantyhose that fit well and are not restrictive [9]. Pantyhose is also intended to reduce fatigue on the legs and hips when wearing heeled shoes. As an index of fatigue reduction, we investigated the surface muscle activity of the lower extremities and examined changes when wearing pantyhose and shoes with different heel heights. The goal of the current study was to develop a pantyhose that reduces leg muscle fatigue when wearing heeled shoes [10]. To achieve this goal, a pantyhose that provides a comfortable fitting sensation was

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developed, and the wear experience of the product and its effect on the muscle activity of the lower limbs was investigated.

2 Experimental Methods

2.1 Participants and Experimental Pantyhose

The participants were 13 healthy Japanese women aged 20–23 years. The participants ate a meal 2 h before the measurement and entered an artificially climate-controlled room (Shinshu University Artificial Climate Experimental System) with an environmental temperature of $24.5 \pm 0.3\,^{\circ}\mathrm{C}$, a relative humidity of $50.0\% \pm 3.0\%$, an illuminance of 827 ± 27.0 lx, and an airflow of 0.8 ± 0.1 m/s. The participants' weight, muscle mass, and body fat mass were then measured using a body composition scanner (InnerScan, TANITA, Japan), and the circumference measurements (above/under bust, waist, lower waist, hip, thigh, above/under knee, calf, ankle, arch) were obtained using a tape measurer. The height measurements (hip, groin, knee, calf) were obtained using a Martin-type human body measuring instrument (Takei Scientific Instruments Co., Ltd., Japan). Changes in muscle activity, clothing pressure and pressure sensation while wearing pantyhose were measured.

Two types of pantyhose were employed in this study. Pantyhose A was a type of basic pantyhose with a single covered yarn (SCY), composed of 20D (2.2 tex) polyurethane/12D (1.3 tex) nylon yarns in the legs. In the panty part of the pantyhose, 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. Based on pantyhose A, pantyhose B was designed to change the supporting pressure of the panty part, wherein a partial double layer with SCY was added. The basic knitting structure of the pantyhose consisted of plain stitches, and the sections of the fabric with partial supporting pressure contained single-rib stitches. The tensile force and strain in the wale direction of the legs and the course and wale directions of the panty part were measured using a KES-FB1-A-AUTO (KatoTech, Kyoto, Japan) with a speed of 0.2 mm/s, chuck size of 5.0 cm, and maximum load of 25 gf/cm at $20\,^{\circ}\mathrm{C}$ and 65% relative humidity at the Fii Research Centre at Shinshu University (used in manual operation). When the sample is cut to a specified size, pantyhose fabric tends to fray, and the obtained fit value is likely to deviate from the actual fit. Therefore, the sample was not cut out, and the measurements were performed with the pantyhose in a pre-cut state [9,11].

2.2 Clothing Pressure and Pressure Sensation

The clothing pressure for the two types of experimental pantyhose was determined by a measuring system based on a hydrostatic pressure-balanced method [12-15]. The clothing pressure was measured at 46 measurement points on the right half of the body, with the cross points positioned between four or five vertical lines (frontal mid/nipple/outside body/dorsal scapula/inside body lines) and eleven (waist, lower waist, hip, groin, tight, upper/lower knee, calf, ankle, arch, toe) planes. The participants wore each type of pantyhose while walking for 30 min for the measurement of muscle activity, as described below in Section 2.3. The pressure sensation was then reported on a visual scale [9,11,16,17].