THE DEVELOPMENT OF E-TEXTILE COMPRESSION PANTS WITH WIRELESS MEASUREMENT OF sEMG

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The application of electronic textiles (e-textiles) on wearable products are increasing since e-textiles can provide clothing comfort properties, including flexibility, permeability, elasticity, washability, and durability. In addition, e-textiles are used as bio-signal measurement electrodes due to their abilities high electrical conductivity and anti-bacterial effects. (Lee et al., 2018; Schneegass & Amft, 2017). In order to measure sEMG (Surface electromyography) through the textile electrode, it is important that electrodes are suitably located at the correct positions so the application of pressure on to the clothing should exceed a certain level. However, even though the locations of electrodes are stabilized with increased pressure on the clothing, the wearers can feel discomfort. The wearing comfort is one of the most important factors when constructing clothing. Thus, this study developed the wireless measurement of sEMG pants to consider wearing comfort based on the clothing construction aspect.

The Size Korea body size of women's in early 20s used to construct the two nude size pattern of compression pants and one pattern was reduced horizontally 10% while the other pattern was reduced horizontally 25%. The bipolar textile electrodes were marked on positions of quadriceps femoris and biceps femoris of hamstring onto the pattern, and then it was embroidered with conductive threads after cutting the fabric. In addition, 9 channel signals were collected through the embroidered ground electrodes located on the inside of the middle back waist belt. The tricot knit with 4-way stretch was used, and electrodes and circuit were stitched using stainless steel threads for the textiles electrodes. Also, PU seam sealing tape was applied to reduce the resistance of the circuit as shown in Figure 1.

Figure 1. Pants for the measurement of sEMG

Participants were 10 women in 20s and 7-points likert scales was conducted for the wearing test of two test pants. They responded to the fitting size of the testing pants by walking for 3 minutes, running in place for 3 minutes, sitting down and standing up for 10 times while wearing the test pants. In addition, they assessed skin abrasion around the electrode and the circuit as well as adhesion of the electrode. The wireless module was applied to the test pants that received excellent result in the wearing test. The sensing module comprises processes which are to amplify signals using pre-amplification at each electrode, and to pass frequencies through the band pass filters, 60

Hz band stop filter as well as low pass filter in order to adjust offset to verify the quality of signal and to out raw data. Bio-signal measurement data from the created module was transferred to users WiFi data with 1000 Hz sampling rate. For this study, module debugging, firmware and software for the measurement were developed. 10 participants wearing compression pants with wireless sEMG assessed the signal transmission quality during isometric exercise. SPSS statistics version 22.0 (IBM software) was utilized for paired t-test statistical analysis and the level of significance was set to $p < 0.05$.

In the result of the evaluation of the two test pants, there were no significant differences between the fit comfort. For the skin abrasion around electrodes, the horizontally reduced 25% pants obtained statistically evaluation with better rating at the biceps femoris electrodes ($t = 2.705$, $p = 0.035$) and the back waist ground electrodes ($t = 2.705$, $p = 0.035$). There was no significant difference between two test pants in the evaluation of the zigzag stitches circuit. Thus, the pattern which was horizontally reduced 25% was used to construct the compression test pants with wireless module applying sEMG measurement for this study. Meanwhile, in the evaluation for the finally selected test pants for the isometric exercise of the femoral region muscle of 10 participants, sEMG signals form 4 channels were suitably transferred to the software. The raw data of one participant is shown in Figure 2.

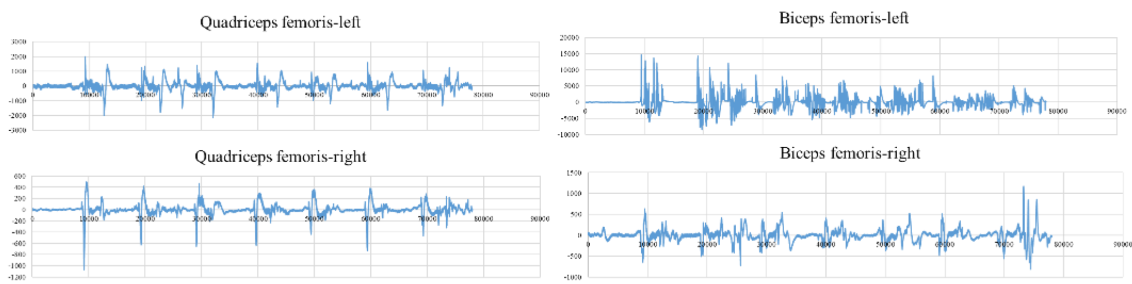

Figure 2. sEMG raw signal for isometric test

This study developed e-textile test pants with wireless measurement of sEMG through a technical clothing design approach. This test pants showed success in both technical aspects and wearing comfort because stable transmission of wireless measurement from electrodes and circuits was achieved in addition to excelling the wearing test for adhesion around electrodes. This means that collections of bio-signal are possible to implement smart wear and textiles for the health care monitoring and military or sport application, which has great substantial meaning in body friendly manner as well.

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