Difference in Movement Magnitude According to the Type of Compression Therapy Used on Healthy Subjects

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Abstract. [Purpose] This aim of this study was to determine the difference in the magnitude of upper extremity movement according to the type of compression device used as determined by three-dimensional motion analysis. [Subjects] The subjects selected for this study were 40 healthy adults. Out of the 40 participants, 9 were excluded from the study. [Methods] For the experimental procedure subjects randomly wore a compression garment, a bandage or neither. During each motion analysis, subjects performed elbow flexion and extension in a fixed range, 10 times, using their dominant hand. [Results] The wrist marker movement distances on the Z axis while wearing the compression garment and bandage were significantly lower than that of wearing nothing. The elbow marker movement distance on the Y axis and range of motion while wearing the compression bandage was significantly greater than that of wearing nothing or the compression garment. The shoulder marker movement distance on the X axis while wearing the compression bandage was significantly greater than that of wearing nothing or the compression garment. [Conclusion] Wearing a compression bandage reduces wrist and elbow movement and increases shoulder movement compared to wearing a compression garment or wearing neither. The appropriate use for a compression garment or a compression bandage must now be determined.

Key words: Compression garment, Compression bandage, Motion analysis

INTRODUCTION

Compression therapy is a technique that aims to achieve maximum limb volume reduction with aesthetic and functional improvement at different levels of disease severity¹). Compression therapy uses a functional compression garment or bandage² ³). Previous studies suggest that compression therapy is effective at reducing the circumference of edema⁴), therefore, it is clinically useful for patients with diseases such as lymphoma, venous ulcer, and deep vein thrombosis. A secondary effect of compression therapy is an improvement in the quality of life⁵). There are numerous studies on the quality of life and upper extremity function following therapy with a compression garment or elastic bandage, which have reported that the quality of life in edema patients, who regularly received compression treatment, improved compared to patients therapy, due to improvement in upper extremity function after compression therapy⁶).

Recently, a comparative study on the use of a compression garment vs. a compression bandage in compression therapy was conducted by King et al. They reported that wearing a compression bandage may lead to a greater reduction in volume, but worse upper extremity functional status as compared to wearing a compression garment⁷). However, because their study used the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire to measure upper extremity function, further evaluation is needed using a more reliable and accurate method. In addition, their study did not report which axis of movement was most limited.

Application of a compression garment or bandage is a useful for decreasing edema, but can cause difficulties with activities of daily living due to the resistance that occurs during movement. Previous studies of gait and motion analysis after application of a compression bandage or orthopedic device on the lower extremity have been conducted, but none have been performed of the upper extremity⁸). Controversy still remains regarding the most effective means of providing compression therapy within the decongestive lymphatic therapy protocol. However, to date there have been no studies that have made use of motion analysis to investigate the differences between compression methods. Therefore, the aim of this preliminary study was to determine the difference in upper extremity movement magnitude using 3D motion analysis while wearing either a compression garment or a compression bandage.

SUBJECTS AND METHODS

This study followed a single-blinded, cross-sectional design, and was carried out at S University laboratory, South
Korea during June 2011. The subjects were 40 healthy adults (20 males, 20 females). Out of the 40 subjects, 9 were excluded from the study due to factors such as the presence of orthopedic or neurologic disease, history of surgery that may have affected the results of the experiment, or limitation of upper extremity range. Informed consent was received from the remaining 31 subjects (18 males, 13 females) prior to their participation in the study. The details of the participants were as follows: mean age, 21.2 ± 3.1 years; mean height, 164.2 ± 12.4 cm, and mean weight, 53.4 ± 10.1 kg. Descriptive statistics were adopted to analyze the general characteristics of the subjects. Movement magnitudes in the X, Y, and Z axes were compared across the compression conditions using 1-way repeated ANOVA. Statistical significance was accepted for values of p<0.05.

The compression garment was a ready-made compression glove (Schiebler, Germany). The compression bandage comprised two 4 cm elastic bandages (Mollelast, Lohmann-Rauscher, Germany), cotton tubular stockinettes (6 cm, Tricofix, BSN-Jobst, USA), a 10 cm foampadding roll (Comprifoam, BSN-Jobst, USA), and one 6-, one 8-, and two 10 cm short stretch bandages (Comprilan, BSN-Jobst, USA). The study participants wore the compression garment, a compression bandage, or neither, in a random order determined by a computer.

The WinArm program (Zebris Medical GmbH, Isny, Germany), which can analyze the movement of the shoulder, elbow, and wrist in three dimensions, was used to evaluate upper extremity movement. To record movement, Compact measuring system 10 software (CMS10, Isny, Germany) was used to extract the components of movement on the X (frontal plane), Y (sagittal plane), and Z (transverse plane) axes. To prevent bias during testing, the subject wore a blindfold (single-blinded) to block visual input, and kept the velocity of movement constant by wearing ear phones linked to a metronome (Metro-tuner MT-30, USA).

IBM SPSS ver. 12.0 software (IBM, Armonk, NY, USA) was used to calculate averages and standard deviations. Descriptive statistics were adopted to analyze the general characteristics of the subjects. Movement magnitudes in the X, Y, and Z axes were compared across the compression methods using 1-way repeated ANOVA. Statistical significance was accepted for values of p<0.05.

Results of the movements among the various conditions (wearing a compression garment, a bandage, or nothing) are shown in Table 1. For the wrist surface marker, movement magnitudes in the Z axis when subjects wore the compression garment or the compression bandage were significantly lower than that of wearing nothing (p<0.05). For the elbow surface marker, movement magnitude in the Y axis and range of motion when subjects wore the compression bandage was significantly lower than that of wearing the

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<th>Table 1. Comparison of the movement magnitudes when subjects wore a compression garment, a bandage, or neither</th>
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<td>Control (A)</td>
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<td>X axis</td>
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<td>Y axis*</td>
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<td>Z axis†</td>
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<td>ROM</td>
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Note. All variables are mean ± standard division. Unit, mm. ROM, range of motion. * a significant difference between interventions (p<0.05).
compression garment or nothing (p<0.05). Shoulder surface marker movement magnitude in the X axis when subjects wore the compression bandage was significantly than that of wearing the compression garment or nothing (p<0.05).

**DISCUSSION**

The aim of this study was to determine the differences in upper extremity motion magnitudes of subjects wearing a compression garment, a compression bandage, or wearing neither. Previous studies have shown a reduction in the circumference of the region of compression in edema patients wearing a compression bandage compared to those wearing a compression garment or hosiery. However, other studies have shown that improper use of a compression bandage may lead to constriction and additional swelling. In addition, using bandages during daily activities can be somewhat cumbersome. Therefore, this study was performed to evaluate what is the most reliable method for constricting movement.

In this study, we measured flexion and extension of the elbow with the arm in contact with the trunk; thus, the surface marker on the wrist reflected the longest travelling path. Our results show that in comparison with the control (no garment or bandage) condition, both the compression garment and the compression bandage reduced movement magnitude in the Z axis. This means that, during elbow flexion and extension, there was a decline in forearm movement in the transverse plane. Previous cadaveric studies have demonstrated that medial and lateral collateral ligament injury alters kinematics in the transverse plane. According to the results of the present study, the reduction in movement magnitude resulting from compression therapy, appears to be due to stability in the Z axis that is guaranteed by compression.

Elbow movement in the Y axis was smallest when the subjects wore a compression bandage. This is because a compression garment only inhibits movement of the forearm and allows the elbow to move freely. Generally, a compression bandage is applied in the same manner as in our study, and includes wrapping of the elbow, which reduces elbow movement. This distinction might not have been clear if a compression garment that covered the elbow had been used.

Results for shoulder movement in the X axis were the opposite of those for the wrist and elbow: subjects wearing the compression bandage showed the larger movement magnitudes than when wearing the compression garment or nothing. This increased movement is compensation for movement restriction of the elbow and wrist. Upper extremity movement is systematic, so in order to overcome one joint constriction, another joint’s, movement must be increased.

In the present study, we measured elbow flexion and extension. One of the most common methods for measuring movement magnitude is using activities of daily life. However, both a compression garment and a bandage support the wrist. Also, research, further of functional movements such as supination and pronation will be necessary in the future.

In conclusion, wearing a compression bandage reduces wrist and elbow movement compared to wearing a compression garment or not wearing either, and this increases the movement of the shoulder. Therefore, determining the appropriate uses for a compression garment or a compression bandage will be necessary.

**REFERENCES**