Effect of Posture during Trumpet and Marching Euphonium Performance on the Trunk and Lower Limb Musculoskeletal System

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Abstract. [Purpose] The purpose of the present study was to investigate the effect of trumpet and marching euphonium performance posture on the trunk and lower limb musculoskeletal system. [Subjects] The subjects were 10 female university students. [Methods] Subjects maintained a resting position, a trumpet performance posture, and a marching euphonium performance posture. The angles and muscle activities of the trunk and lower limbs were then measured. [Results] The anterior tilt angle of the trunk decreased significantly in the trumpet and marching euphonium performance postures compared with the resting standing position, as well as in the marching euphonium performance posture compared with the trumpet performance posture. The muscle activity of the cervical paraspinal muscles, upper fibers of the trapezius, and lumbar paraspinal muscles increased significantly in the marching euphonium performance posture compared with the resting standing position, as well as in the marching euphonium performance posture compared with the trumpet performance posture. [Conclusion] The results suggest that the performance position for trumpet and the marching euphonium performance increases the load on the cervical and thoracic musculoskeletal system, which increases with greater instrument weight. However, the same instrument performance postures had no affect on the musculoskeletal system of the lower limbs. 

Key words: Posture, Trunk, Lower limb

INTRODUCTION

Musicians often experience musculoskeletal pain as a result of lengthy and long-term instrument performance. More students enrolled in music schools note upper limb pain compared with students enrolled in ordinary schools3). It has also been reported that the incidence of upper limb pain is higher in those who have longer practice times. Therefore, it can be said that upper limb pain in musicians is a symptom of overuse, with lengthy and long-term instrument performance being contributing factors. Musculoskeletal pain in musicians is common not only in the upper limbs but also in the lumbar and cervical regions, as well as in the shoulder girdle2). The characteristics of pain in musicians differ according to instrument type2). For example, it is conceivable that when playing a heavy instrument such as the tuba, a large load is applied to the trunk to maintain the performance posture. Furthermore, as instruments in a marching band are played while marching, a large load is probably also applied to the lower limbs.

Instrument type and performance posture are thought to be important factors mediating pain3). However, the performance postures of various types of instruments have not been sufficiently investigated. Thus, the present study clarified the characteristics of the standing performance posture for the trumpet and the marching euphonium and investigated the effect of the performance postures of these instruments on the lower limb musculoskeletal system.

SUBJECTS AND METHODS

The subjects were 10 female university students in Japan. Their (mean ± SD) age was 20.5 ± 1.3 years, their height was 159.6 ± 6.2 cm, and their weight was 55.1 ± 7.2 kg. Their instrumental performance history was 5.1 ± 2.0 years. Because the subjects were not professional trumpet or marching euphonium performers, they all received sufficient instruction from the instructor regarding the trumpet and marching euphonium performance posture prior to measurements. The purpose and contents of the study were sufficiently explained to the subjects, whose consent to participate in the study was obtained. Additionally, approval was obtained from the Shijonawate Gakuen University ethics committee (approval number 23-2).

The subjects adopted a closed-leg resting standing position, a trumpet performance posture, and a marching eu-
The angles of the trunk and lower limbs were measured while the postures were maintained. The measurement was performed in the sequence of the resting standing position, the trumpet performance posture, and the marching euphonium performance posture. The trunk and lower limb angles were measured using a three-dimensional motion analysis device (CMS-HS, Zebris Medical GmbH, Isny, Germany). Markers were attached to the lateral malleolus, lateral epicondyle of the femur, greater trochanter, and acromion on the left side of the subjects. The sampling frequency was 100 Hz, and the measurement time was 10 s. Measurements were performed as soon as the subjects could maintain a stable performance posture. The collected data were processed by image analysis software (Win-Date, Zebris Medical GmbH), and the average amplitude of the central three seconds was determined. The average amplitude of each muscle was normalized as 100% according to the average amplitude of the 3-s maximum voluntary contraction.

Statistical analysis entailed a one-way analysis of variance and multiple comparison using Tukey’s method. Significance was accepted for values of p<0.05. IBM SPSS Statistics 20 for Windows was used for statistical analysis.

### RESULTS

The anterior tilt angle of the trunk decreased significantly in the trumpet and marching euphonium performance postures compared with the resting standing position, as well as in the marching euphonium performance posture compared with the trumpet performance posture (Table 1). The muscle activity of the cervical paraspinal muscles, upper fibers of the trapezius, and lumbar paraspinal muscles increased significantly in the marching euphonium performance posture compared with the resting standing position, as well as in the marching euphonium performance posture compared with the trumpet performance posture (Table 2). However, there were no significant differences in other measurement items between the postures.

### DISCUSSION

The anterior tilt angle of the trunk can be rephrased as an increase in the posterior tilt angle of the trunk. Posterior tilt angle of the trunk increases in line with instrument weight. This is likely a means for maintaining the combined center of gravity of the instrument and the body in the most stable position possible. An increase in the posterior tilt angle of the trunk increases the lumbar lordosis angle. This increase results in tension being applied to the anterior tissues of the lumbar spine, such as the anterior longitudinal ligament, and compressive force being applied to the zygapophyseal joints. Christie et al. reported that an increase in the lumbar lordosis angle while standing is associated with chronic low back pain. Consequently, maintaining the performance posture for the trumpet and the marching euphonium for a long period can contribute to low back pain.

No significant difference was found in the muscle activities of the lumbar paraspinal muscles between the resting
standing position and the trumpet performance posture, but a significant increase was noted in the marching euphonium performance posture compared with the resting standing position. The lumbar paraspinal muscles are antigravity muscles which are contracted continuously while standing, thus easily incurring mechanical stress. It is conceivable that, since the muscle activity of the lumbar paraspinal muscles increases during the marching euphonium performance posture, holding the performance posture for a long time increases the load on the lumbar paraspinal muscles and is therefore a factor leading to lumbar fatigue and low back pain. The muscle activity of the upper fibers of the trapezius increases in line with instrument weight in the trumpet to marching euphonium postures. When holding these instruments, the shoulder joint flexes and abducts, while the scapula rotates up and elevates. The muscle activity of the upper fibers of the trapezius is likely to increase to maintain such a posture. We also found that muscle activity of the cervical paraspinal muscles increased significantly in the euphonium performance posture compared with the resting standing position. Since the posterior tilt angle of the trunk increases in the marching euphonium performance posture, it is necessary to tuck in the chin to face forward. The posture of tucking in the chin is called the “chin-in posture” and is considered a posture in which the muscle activity in the cervical area including the cervical paraspinal muscles increases. Sustained contraction of these muscles is a likely factor of muscle fatigue. Furthermore, obstruction of blood flow by sustained muscle contraction will result in myalgia. Therefore, holding the trumpet and marching euphonium performance postures for a long time would be factors of myalgia.

The present findings suggest that the trumpet and marching euphonium performance postures increase the load on the cervical and trunk musculoskeletal system. Moreover, the load on the musculoskeletal system increases in line with increased instrument weight. However, the trumpet and marching euphonium performance postures do not affect the musculoskeletal system of the lower limbs. Therefore, we consider it important to evaluate the cervical and trunk musculoskeletal systems and to conduct conditioning coaching appropriate for trumpet and marching euphonium performers. Because these instruments are supported by the left hand and played with the right hand, the trunk and lower limb musculoskeletal system on the left side, that is, the supporting side, was measured in the present study. We plan to measure the trunk and lower limb musculoskeletal system on the right side to elucidate the effect of performance postures on the whole body. In addition, it is possible that the trunk and lower limb musculoskeletal system is affected differently by the technique used to hold the instrument with the left hand during trumpet and the marching euphonium performance. Because the angles and muscle activities of the upper arm were not measured in the present study, we plan to perform these measurements in a future study to elucidate the influence of different instrument holding techniques on the trunk and lower limb musculoskeletal systems.

### Table 2. The muscle activities of the trunk and lower limbs

|                     | Standing position | Trumpet performance posture | Marching euphonium performance posture |
|---------------------|-------------------|----------------------------|---------------------------------------|
| Cervical paraspinal muscles (%) | 9.9 ± 8.0         | 13.8 ± 10.3                | 18.9 ± 15.1                           |
| Upper fibers of the trapezius (%) | 4.8 ± 3.1         | 11.4 ± 6.0                 | 21.8 ± 12.6                           |
| Lumbar paraspinal muscles (%) | 13.9 ± 13.2       | 17.0 ± 12.4                | 21.5 ± 13.7                           |
| Gluteus maximus (%) | 25.9 ± 15.3       | 26.8 ± 16.8                | 28.2 ± 17.4                           |
| Rectus femoris (%) | 19.7 ± 16.9       | 18.4 ± 15.3                | 17.8 ± 14.1                           |
| Biceps femoris (%) | 12.5 ± 6.2        | 13.2 ± 6.9                 | 15.2 ± 8.7                            |
| Lateral head of the gastrocnemius (%) | 13.6 ± 9.4       | 13.6 ± 5.8                 | 14.3 ± 6.2                            |

Mean ± SD

a: Significant difference between the standing position and the marching euphonium performance posture (p<0.01)
b: Significant difference between the standing position and the marching euphonium performance posture (p<0.05)
c: Significant difference between the trumpet performance posture and the marching euphonium performance posture (p<0.001)

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