ACUTE EFFECTS OF STATIC STRETCHING ON FORCE OUTPUT OF DORSI FLEXORS IN DANCE STUDENTS

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The purpose of this study was to investigate the effect of static stretching on maximal force production of the dorsi flexors in dance students who had been performing stretching exercise regularly. Eight female university students in the department of dance and dance education, and nine female university students without dance experience performed a maximal voluntary contraction of the dorsi flexors after six minutes of static stretching. After static stretching, maximal voluntary force of dorsi flexors decreased significantly in both groups, while the joint range of motion in plantar flexion was significantly higher in the dance students compared with the non-dancers. These results suggest that prolonged stretching exercise induces a similar deficit in force production after acute static stretching in both dancers and non-dancers.

KEY WORDS: dance, static stretching, force production.

INTRODUCTION: An acute bout of static muscle stretching can diminish force output or performance (Kokkoen et al., 1998, Avela et al., 1999) through two possible mechanisms: a change in active musculotendinous stiffness, and a depression of muscle activation. On the other hand, regular stretching training also inhibits the excitability of the stretch reflex induced by muscle stretching. Dance students perform stretching exercises regularly to improve their flexibility. The acute effects of static stretching on force output may therefore differ between dancers and non-dancers. We investigated the acute effect of static stretching on force output of dorsi flexors in dance students and students without dance experience. We hypothesized that acute static stretching would reduce force output to a smaller extent in dancers compared with non-dancers. The basis for this hypothesis on was that regular stretching induces adaptive responses in either musculotendinous architecture or neural pathways.

METHOD: Data Collection: Subjects were eight healthy female university students in the department of dance and dance education (mean age; 21.4 ±1.3 years, height; 1.58±0.06 m, body mass; 51.9 ±6.4 kg, %body fat; 21.4±1.3 %) and nine healthy university students without dance experience (mean age; 20.2 ±1.5 years, height; 1.59±0.05 m, body mass; 49.3 ±4.5 kg, %body fat; 21.4±2.6.%). Dance students had been taking classical ballet or modern dance classes more than two days per week. Their dance experience was 5.2±3.4 years. All subjects visited our laboratory on three separate days. On the first visit, subjects were asked to perform maximal dorsi flexion to be familiar with the testing protocol. Subjects sat on a test bench with hip joint at 90° flexion. The ankle joint was set at 0°, with the knee joint at full extension. The waist was secured by adjustable lap belts, and held in position. The foot was securely strapped to a footplate connected to the lever arm of the force platform (Kyowa dengyo, Japan). The force platform was attached to the sole of the subject's foot. The torque (Nm) during dorsi flexion with maximal effort was detected by the force platform. The range of motion in the ankle joint during plantar flexion and dorsi flexion were also measured at the first visit using a goniometer. A sit and reach test was also performed to evaluate each subject's overall flexibility. On the second or third visit, subjects performed maximal voluntary dorsi flexion before and after six minutes static stretching or six minutes rest with the same testing setup as the first visit. Subjects did not warm up before the six minutes of static stretching or at rest. During testing, room temperature was set at 25°C. Surface electromyogram (EMG) was recorded from the medial heads of gastrocnemius, soleus, and

tibialis anterior muscles. Integrated EMG (iEMG) was calculated and normalized by the maximal voluntary contraction (%MVC). Electo-mechanical delay (EMD) was also calculated from the time series data of EMG and force output.

Data Analysis: Two-way ANOVA with repeated measures was used to analyse all variables. Post-hoc analysis of mean value was performed using Turkey's significant difference method. $P<0.05$ was accepted for statistical significance.

RESULTS: Range of motion (ROM) in plantar flexion and the results of sit-and-reach test were significantly higher in the dance students compared with the non-dancers, but ROM in dorsi flexion was similar between two groups.

After six minutes of static stretching, ROM of plantar flexion increased significantly in both groups (Figure 1).

Maximal voluntary force decreased significantly after six minutes stretching in both groups (Figure 2.), while there was no significant change in force output between before and after six minutes rest in the control trial. Integrated EMG also decreased after stretching. EMD did not change significantly before and after stretching, however EMD tended to increase more in the dance students before and after stretching compared with the non-dance students.

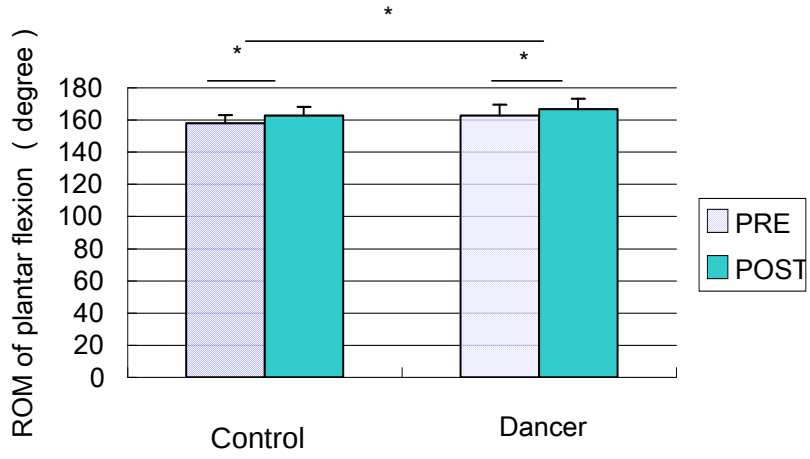

Figure 1 Range of motion in plantar flexion (dorsi flexors) for both groups before and after acute stretching

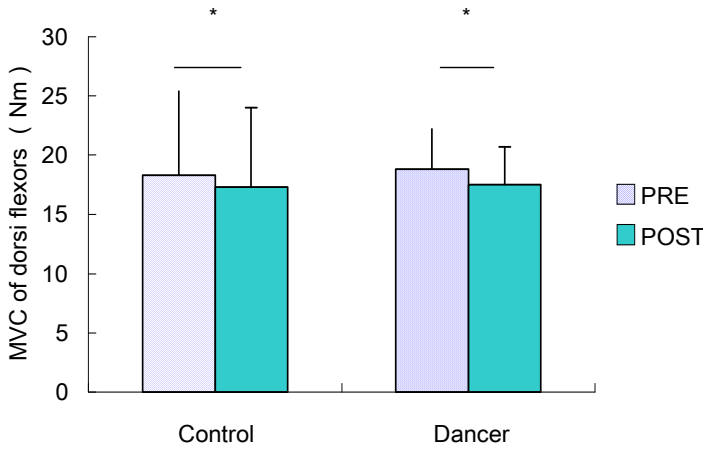

Figure 2 MVC force during dorsi flexion for both groups before and after acute stretching

DISCUSSION: The only adaptive response to regular stretching exercise in the dance students was greater flexibility in plantar flexion. The significant increase in ROM for plantar flexion after six minutes acute stretching in both groups indicates that muscle stretching increased joint mobility. In contrast to our hypothesis, maximal voluntary force and muscle activity in dorsi flexion decreased in both dance students and non-dance students. We propose that force deficit after acute stretching in this study would mainly due to changes in neural activity. In our previous studies, advanced dancers showed different responses in musculotendinous properties after stretching compared with the non-dancers. Future studies could assess the effects of force output individuals with great joint mobility, such as professional dancers.

CONCLUSION: Acute static stretching reduced force production and muscle activity during dorsi flexion in both dance students and non-dance students. Contrary to our hypothesis, the acute effect of passive muscle stretching was not dependent on joint ROM.

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