Task-specific Tremor in Violinists: Evidence of Coactivation in the 3 to 8 Hz Frequency Range

André Lee, MD,1 Kenta Tominaga, MSc,1,2 Shinichi Furuya, PhD,1 Fumio Miyazaki, PhD2 and Eckart Altenmüller, MA, MD1*

1Institute for Music Physiology and Musicians’ Medicine, Hannover University for Music, Drama, and Media, Hannover, Germany
2Department of Engineering Science, Osaka University, Osaka, Japan

ABSTRACT

Background: Task-specific tremor in musicians severely impairs fine motor control. However, little is known about its pathophysiology. Here, we quantify electromyography (EMG) properties in primary bowing tremor—in particular, muscular coactivation—to determine whether primary bowing tremor affects a specific frequency range of coactivation.

Methods: We quantitatively compared EMG properties of the wrist muscles between 4 professional violinists who had task-specific tremor and 4 age-matched healthy controls.

Results: We observed bowing tremor-specific muscular coactivation in the frequency range of 3 to 8 Hz only in the patients but not in the healthy controls. No muscular activity was observed at the resonance-frequency range.

Conclusions: Our findings indicate an association between coactivation and bowing tremor at a specific frequency range (3–8 Hz). The absence of EMG activity and coactivation in the mechanical-reflex frequency of the wrist suggests that central mechanisms play a more dominant role than mechanical-reflex mechanisms in primary bowing tremor. © 2013 Movement Disorder Society

Key Words: tremor; electromyography; task specificity; dystonia; musicians

Task-specific tremors (TSTs)1 may impair fine motor control of highly trained tasks. In string instrument players, tremor may occur in the right arm while playing the instrument.2,3 However, little is known about its pathophysiology. Therefore, we quantified electromyography (EMG) properties in primary bowing tremor (PBT), a TST that affects the right arm of violinists. We were specifically interested in the quantification of coactivation, which, to our knowledge, has not been done to date, to investigate whether a specific frequency range for coactivation and, subsequently, a correlation between PBT and coactivation exists.

Participants and Methods

Surface EMG (Biovision, Wehrheim, Germany) was measured in 4 professional violinists (ages 48–62 years; median age, 53.5 years) with PBT and in age-matched, healthy violinist controls (ages 44–68 years; median age, 53.5 years; Wilcoxon rank-sum = 8; P = 1.00). Frequency and coactivation4 of wrist extensor and flexor muscles were compared. We chose the muscle groups according to clinical observation and patient reports; however, we are aware that other sources of tremor (more peripherally/proximally) cannot be excluded. We measured 2 conditions paced by a metronome (40 beats per minute) requiring slow bowing movements and elicited tremor: a G-major scale with 2 beats (the GM condition) and open strings with 4 beats per bow-stroke (the open strings [OS] condition). These 2 different bowing speeds served to investigate an influence of bowing speed on tremor. The GM condition served to assess the influence of bimanual coordination by using the fingers of the unaffected hand. We subdivided the frequency into 3 ranges (1–3 Hz, 3–8 Hz, and 8–12 Hz).1,5,6

Results

In the frequency domain, the difference between the conditions was nonsignificant with the small numbers involved (t test; P = 0.34) (Fig. 1A–C). We observed PBT-specific EMG activity in the frequency range
from 3 to 8 Hz (mean, 6.6 Hz) only in the patient group and not in the control group. Coactivation occurred in the same frequency range at a mean frequency of 6.6 Hz. No coactivation at that frequency range was evident in the control group (Fig. 1A). For both groups, no EMG activity was observed at higher frequencies (8–12 Hz). A 3-way analysis of variance (ANOVA) revealed a significant effect only for group (P = 0.002) and muscle (P = 0.008) but not for condition (P = 0.9). An interaction between group and muscle was observed. EMG activity was higher for patients in both muscles for both conditions (P < 0.05) (Fig. 1B). An ANOVA revealed a significant effect only for group (P = 0.002) and frequency range (P = 0.008) but for not condition (P = 0.7). An interaction effect was identified for group and frequency range, indicating a difference between groups at a particular frequency range. Indeed, tremor power was significantly greater in the frequency range from 3 to 8 Hz than in the other ranges (P < 0.05). Differences between 1 to 3 Hz and 8 to 12 Hz were not significant. Differences between groups was significant for only the 3 to 8 Hz range (P < 0.01) (Fig. 1C).

**Discussion**

Our findings demonstrate a difference in the spatial and frequency features of muscular activity between groups. To our knowledge, this provides the first quantitative evidence of altered muscular control in PBT. The findings of a specific frequency range, common for other TSTs, and a lack of activity at the wrist’s resonance frequency (8–12 Hz), physiological tremor, or at lower frequencies than TST, indicate that central mechanisms play a more dominant role than mechanical reflex mechanisms at the wrist or enhanced physiological tremor. Furthermore, we observed for the first time that coactivation occurred continuously (rather than alternatingly) at a frequency range similar to that of muscle activity, providing evidence supporting a correlation between coactivation and TST.
Legend to the Video

One patient playing the open string (OS) condition. Part of the playing on the A-string and the E-string is shown. Tremor of about 6 Hz is audible and visible, clearly impairing the tone quality. Tremor amplitude is higher at the nut of the bow and when playing down-bow, whereas up-bow playing and playing at the tip of the bow is less impaired.

References


