

Relationship between eye-lens accommodative response and trapezius muscle activity during manual tracking of a visual target

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1. Introduction

Eye-lens accommodation is integrated with functionality of the neck-scapular area muscles that contribute to coordination between movements of the eyes and the head for stabilization of gaze. Laboratory studies under static gaze and postural conditions have shown that high accommodation/vergence demands are associated with higher trapezius muscle activity and thus may be a risk factor for development of chronic muscle pain in the neck-shoulder area under unfavorable visual and postural ergonomic conditions. In the present study we extended and developed the previously used methodology and looked at the relationship between accommodation/vergence visual load and trapezius muscle activity in a more natural dynamic motor task under free gaze conditions.

2. Methods

Twelve young healthy participants (5 men and 7 women) continuously tracked on a computer screen for 7 minutes a slowly moving (5mm/s) central target, a low contrast circle with a diameter of 5 mm, with a digital pen held in the dominant hand. The head was restrained to keep the eyes-screen distance at 40 cm (2.5 diopters). Participants' eye refraction was corrected to normal, if necessary. Each participant's eye-lens accommodative response was continuously recorded via infrared photorefraction measurements.

Trapezius muscle activity was continuously measured bilaterally with bipolar surface electromyography (EMG). The EMG electrodes were placed on the upper part of the trapezius muscle at one-third of the distance (laterally) between C7 and the lateral side of the acromion process. The EMG recordings were root-mean-square (RMS) converted in 0.1-s periods, and adjusted for noise in a power sense. The RMS values were normalized to submaximal reference contractions, and expressed in %RVE (reference voluntary electrical activity). The 50th percentile, i.e., the median, of the normalized RMS values was used to quantify muscular activity level. Median values of the 1st through the 7th minute of the task and of the full seven minutes were computed.

Tracking error was computed from continuously sampled coordinates of the pen tip and the target. The mean of the individual eye-lens accommodative response computed over the full 7 minutes tracking period equaled 2.5 diopters (range 1.7-3.7 diopters), which

corresponded closely to the stimulus dioptric distance to the target. Ciliary muscle contraction force during tracking was computed for each participant from the accommodation response and age depended dioptric force coefficient.

3. Results

Stepwise linear regression analysis showed a significant effect of ciliary muscle contraction force on trapezius muscle activity on the dominant tracking side, i.e. activity of the trapezius muscle was higher in participants with greater eye-lens accommodative response (Fig. 1). The relationship was significant for the trapezius EMG and ciliary muscle contraction force averaged across 7 minutes of the task, as well as for each minute. The results generally support the idea that high accommodation/vergence demands during continuous eye-hand coordination may increase muscle tension and contribute to development of musculoskeletal complaints in the neck-shoulder area. However, further studies are required to clarify, whether the relationship is valid within each individual or may represent a personal trait, when people with higher eye accommodation response may tend to have higher trapezius muscle activity.

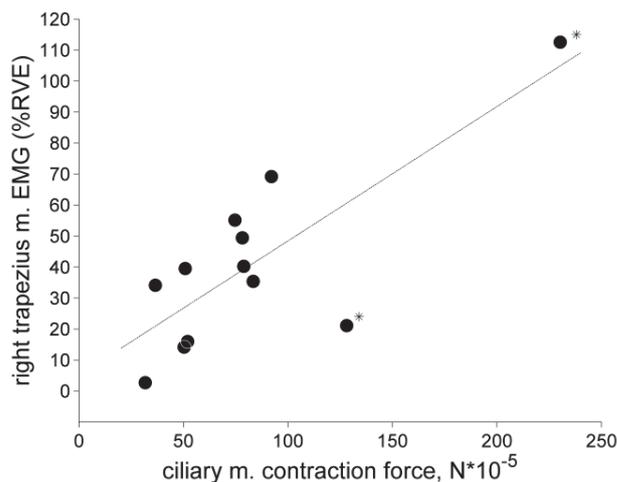


Figure 1.

Relationship between ciliary muscle contraction force and trapezius muscle activity on the dominant tracking side. Average values across 7 minutes of the task are shown. Each filled circle represents one participant. Correlation coefficient is 0.79, $p < 0.003$ for data from all 12 participants. The significance of the relationship is preserved also after removal of two exceptionally high values of ciliary muscle contraction force (marked with asterisk), correlation coefficient is 0.79, $p < 0.008$.