CERVICAL MUSCLE REFLEXES DURING LATERAL ACCELERATIONS

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Introduction

Autonomous vehicles will allow a variety of seating orientations that may change the risk of neck injury during an accident. Having a rotated head at the time of a rear-end collision in a conventional vehicle is associated with a higher risk of acute and chronic whiplash [1]. The change in posture affects both the movement of the head and the response of the muscles [2]. We are studying the reflexes of the muscles of the neck so that we can validate the responses of digital human body models that are used in crash simulations.

Methods

The neck movements and muscle activity of 21 participants (11 female) were recorded at the Stuttgart FKFS* mechanical driving simulator. The simulator executed driving maneuvers that generated lateral accelerations of up to 5m/s^2. Recordings were made in two conditions: one in which the participants looked ahead (0°, 6 trials), and another where they looked to the right (45°, 4 trials). The study was approved by the ethical committee of the University of Stuttgart (Az 22-001) and was conducted in accordance with the latest declaration of Helsinki.

During the maneuver we recorded the acceleration of the seat and electromyographic (EMG) signals from the sternocleidomastoid (STR) muscles using a Biopac MP 160 system (USA). EMG signals were high-pass filtered (500Hz), full wave rectified, low-pass filtered (10 Hz), and then normalized using data from a maximum voluntary contraction trial. EMG onset latency was evaluated between the onset of the acceleration of the seat and the onset of the normalized EMG of the STR muscles. The normalized EMG peak that occurred immediately following the onset was taken to be the strength of the reflex.

Results

The left and right STR muscles have reflexes that vary with the direction of the movement and the posture of the neck (Figure 1). As intuition would suggest, when moving to the right the activity of the right STR is earlier and stronger than the left STR (see the 3rd and 1st columns of Figure 1A and B for 0° and 45°). A similar but opposite pattern is observed when the seat moves to the left. The pattern of onset latency of the 0° and 45° trials are similar, but the reflex strengths differ.

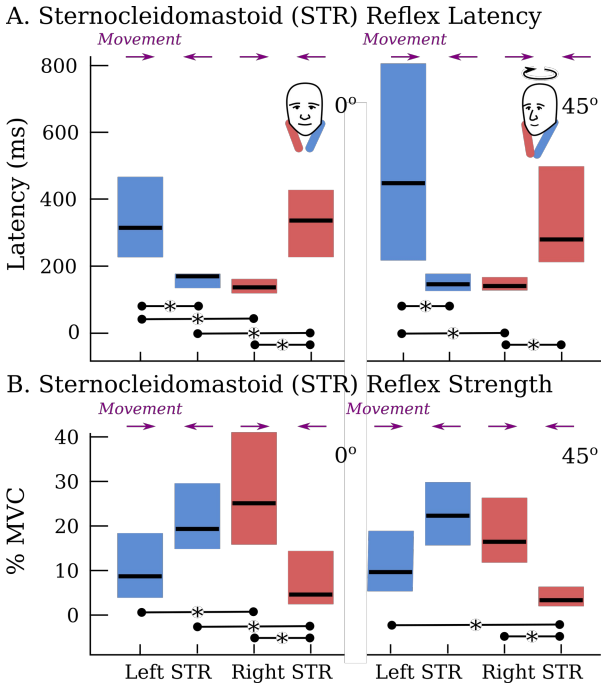

Figure 1: The reflex latency and strength of the left (blue) and right (red) STR muscles is shown during lateral accelerations to the left and right (see purple movement annotation) in two conditions: looking straight ahead, and looking to the right by 45°. Plots include the 25th-75th percentile data and medians.

Discussion

Similar to a smaller previous study [2] we found muscle activity of the neck is sensitive both to direction and posture. We plan to extend this work by examining how these responses differ across men and women, and also how these patterns compare with the other muscles we recorded (upper and lower trapezius).

References

1. Jakobsson et al. Traffic Inj. Prev., 9:600-5, 2008.
2. Kempter et al. Ann Biomed Eng, 1-12, 2022.

Acknowledgements

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*https://www.fkfs.de/en/test-facilities/driving-simulator/stuttgart-driving-simulator