Immediate effects of a passive neck exoskeleton on upper trapezius muscle activity during neck flexion

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Summary

This pilot study investigates the efficacy of a novel passive neck exoskeleton (NECXO) in reducing upper trapezius muscle activity during sustained neck flexion. NECXO utilizes an elastic band aligned parallel to neck muscles to provide support and potentially alleviate cervical spine loading.

Introduction

Neck pain has become a prevalent problem in today's society and has impacted the lives of over 200 million people globally as of 2020 [1]. The most commonly identified risk factor is working with prolonged bent neck posture which causes neck muscle strain, increasing the likelihood of neck pain [2]. To address this, we developed NECXO, a passive neck exoskeleton that provides support via an elastic band connecting the headgear to a shoulder brace. This study investigates whether NECXO reduces upper trapezius (UT) muscle activity at varying neck flexion angles.

Methods

Ten healthy young adults (8 males, 2 females; age = 23.9±1.7 years) participated in this interventional study. NECXO offloaded neck extensors during forward head posture with an elastic band of uniform stiffness across participants. The participants maintained fixed neck angles (15°, 30°, 45°, and 60°), while watching a video on their mobile phones. The upper trapezius muscle activity was recorded using surface electromyographic sensors (Delsys, Boston, USA, 2000 Hz). Each trial lasted 1.5 minutes with a 2-minute rest between trials. EMG signals were processed using Delsys EMGWorks software. A 4th -order Butterworth bandpass filter was applied to process the EMG signals. RMS values of the filtered signals were computed using a 125 ms moving window (50% overlap) and normalized to each participant's maximum voluntary contraction (MVC). Participants also provided qualitative feedback on their NECXO experience.

Results and Discussion

Results showed no statistically significant differences in UT muscle activity between NECXO assisted and unassisted conditions across all flexion angles (p>0.05). Effects of NECXO for different angles were subject-specific as shown in Fig 1. This variability in participant responses can be attributed to individual differences in response to the elastic band of same stiffness. While many found NECXO beneficial at greater flexion angles, some reported increased effort to maintain forward head posture. The position of arms during trials and limited exoskeleton acclimation times may have led to muscle over compensation resulting in increased UT muscle activity levels.

Conclusions

Though not statistically significant, reductions in muscle activity were observed after the NECXO intervention, potentially indicating that it can offload the neck extensors for prolonged periods of forward head posture. Future studies with larger sample sizes and personalized exoskeleton tuning to study the potential benefits of NECXO in offloading neck extensors during prolonged flexion need to be conducted.

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References

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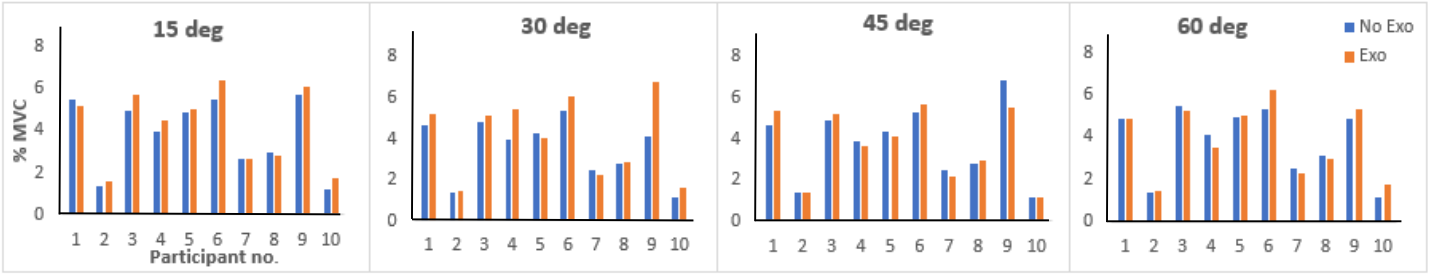

Figure 1: Normalized RMS values of UT muscles for various neck flexion angles before and after NECXO intervention