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The Impact of Prolonged, Constrained Computer Work on Cervical Spine Proprioception and Trapezius Muscle Activity: An Observational Study

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ABSTRACT

Objective: This observational study aimed to quantify the acute effects of a standardized 90-minute computer work session on cervical joint position sense (JPS) error and upper trapezius muscle activity in asymptomatic adults.

Methods: Thirty-five office workers (mean age 29.4 ± 5.1 years) with no recent neck pain participated. Cervical JPS was assessed via head-mounted laser pointer for target-matching accuracy in flexion, extension, and rotation. Surface electromyography (sEMG) recorded normalized root-mean-square (RMS) activity from the bilateral upper trapezii during a standardized typing task. Measurements were taken pre-session (T0), immediately post-session (T1), and after a 15-minute break (T2).

Results: A significant increase in mean cumulative JPS error was observed at T1 (4.7° ± 1.2°) compared to T0 (3.1° ± 0.9°; $p<0.001$). Error remained elevated at T2 (4.1° ± 1.1°; $p=0.003$ vs. T0). sEMG revealed a significant increase in normalized RMS activity in the dominant-side trapezius at T1 (15.4% ± 3.1% MVC) compared to T0 (12.1% ± 2.8% MVC; $p=0.002$). Asymmetry in muscle activity (dominant vs. non-dominant) also increased significantly at T1 ($p=0.01$).

Conclusion: A single bout of prolonged computer work leads to measurable deficits in cervical proprioception and altered trapezius muscle activation patterns, which do not fully recover after a short break. These acute physiological changes may represent early, sub-clinical risk factors for the development of work-related musculoskeletal disorders.

Introduction

Neck pain is a prevalent issue among office workers, with a significant proportion attributed to prolonged computer use [1]. While the link between posture and pain is established, the underlying physiological mechanisms are multifaceted. Beyond static postural analysis, alterations in neuromuscular control—specifically cervical proprioception and muscle activation patterns—are hypothesized to be critical precursors to pain and injury [2]. Cervical joint position sense (JPS) is essential for precise head movement and stability, and its impairment is a documented feature in chronic neck pain populations [3]. Similarly, altered activity and early fatigue in the upper trapezius muscles are commonly observed during constrained work [4]. However, most research focuses on chronic patients or short-duration lab tasks. There is a paucity of observational data documenting the *acute* physiological changes in these parameters following a realistic, prolonged computer work session in asymptomatic individuals, which could identify early, reversible risk states.

Identifying sub-clinical physiological changes before the onset of pain is crucial for proactive ergonomic and therapeutic interventions. If prolonged computer work induces acute, measurable deficits in proprioception and muscle function, these markers could serve as objective targets for workplace assessment and the timing of microbreaks. This study bridges a gap by observing these key neuromuscular parameters not only immediately after work but also after a typical short break, providing insight into recovery dynamics. The findings could inform evidence-based guidelines for work-rest cycles and preventative exercise programs aimed at maintaining cervical sensorimotor function.

Objectives

1. To measure the change in cervical joint position sense (JPS) accuracy following a 90-minute period of standardized computer work.
2. To quantify changes in the amplitude and symmetry of upper trapezius muscle activity during a standardized typing task before and after the work period.
3. To assess the degree of recovery in JPS and muscle activity parameters following a 15-minute passive break.

Materials and Methods

This was an observational laboratory study conducted in a controlled ergonomics laboratory.

Participants: Thirty-five asymptomatic office workers (20 female, 15 male), aged 25-40 years, who used a computer for >6 hours per day were recruited via institutional email. Exclusion criteria included any history of neck pain requiring treatment in the past 6 months, diagnosed cervical spine pathology, vestibular disorders, or recent upper limb injury.

Materials:

- **Workstation:** An adjustable office chair and desk with a standard keyboard, mouse, and 24-inch monitor positioned at eye level.
- **JPS Assessment System:** A lightweight helmet fitted with a laser pointer. A target board with a 1cm grid was positioned 1m from the participant's head.
- **Electromyography:** A wireless sEMG system (Trigno, Delsys Inc.) with bipolar Ag-AgCl electrodes. Data was sampled at 2000 Hz.
- **Software:** Custom LabVIEW program for timing JPS trials, and EMGWorks® for sEMG data acquisition and initial processing.

Procedures:
After providing informed consent, demographic data was collected. sEMG electrodes were placed on the bilateral upper trapezius (midpoint between C7 and the acromion) after skin preparation [5].

1. **Baseline (T0):** *JPS Test:* Blindfolded, participants performed active head repositioning to a neutral target position, then to memorized targets of 30° flexion, 20° extension, and 45° left/right rotation. Absolute error (distance between laser points) was calculated in degrees for 3 trials per direction. *sEMG Task:* Participants typed a standard paragraph for 2 minutes. The middle 30 seconds of stable typing were analyzed.
2. **Intervention:** Participants engaged in 90 minutes of their own computer-based work (document editing, data entry). Posture was not constrained but monitored.
3. **Post-Work (T1):** The T0 JPS and sEMG protocols were repeated immediately.
4. **Post-Break (T2):** After a 15-minute seated rest break (no phone use), the protocols were repeated a final time.

Data Analysis: sEMG signals were band-pass filtered (20-450 Hz), full-wave rectified, and smoothed (RMS, 50ms window). RMS amplitude was normalized to a maximum voluntary contraction (MVC) performed at T0. Mean normalized RMS and an asymmetry index [(Dominant - Non-dominant) / (Dominant + Non-dominant)] were calculated. JPS errors were averaged across directions for a cumulative score. Data were analyzed using repeated-measures ANOVA with Bonferroni post-hoc tests ($\alpha=0.05$). Statistical analysis was performed in SPSS v.26.

Results

Cervical Joint Position Sense: A significant main effect of time was found for cumulative JPS error ($F(2,68)=24.73$, $p<0.001$). Post-hoc tests revealed a 52% increase in error from T0 to T1 ($p<0.001$). Although error decreased slightly from T1 to T2, it remained 32% higher than baseline ($p=0.003$) (Table 1).

Table 1: Cervical Joint Position Sense (JPS) Error (degrees, Mean ± SD)

Measurement Time	Cumulative JPS Error (°)	p-value (vs. T0)
T0 (Baseline)	3.1 ± 0.9	-
T1 (Post-Work)	4.7 ± 1.2	<0.001
T2 (Post-Break)	4.1 ± 1.1	0.003

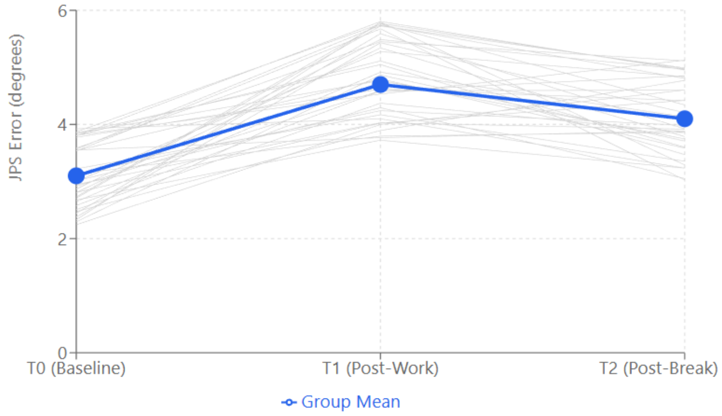
Trapezius Muscle Activity: Normalized RMS activity in the dominant trapezius increased significantly from T0 to T1 ($p=0.002$) and remained elevated at T2 ($p=0.021$). Non-dominant activity showed no significant change. Consequently, the muscle activity asymmetry index increased significantly at T1 ($p=0.01$) (Table 2).

Table 2: Normalized Upper Trapezius EMG Activity (%MVC, Mean ± SD)

Measurement Time	Dominant Side	Non-Dominant Side	Asymmetry Index
T0 (Baseline)	12.1 ± 2.8	11.8 ± 2.5	0.013 ± 0.05
T1 (Post-Work)	15.4 ± 3.1*	12.5 ± 2.7	0.104 ± 0.06*
T2 (Post-Break)	13.9 ± 2.9*	12.1 ± 2.6	0.069 ± 0.05

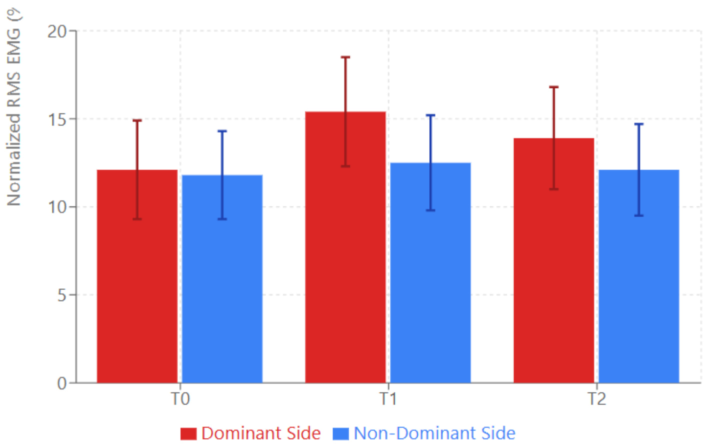
- $p<0.05$ vs. T0 for Dominant side; * $p=0.01$ for Asymmetry Index T1 vs. T0.

Figure 1: Mean Cumulative JPS Error Over Time



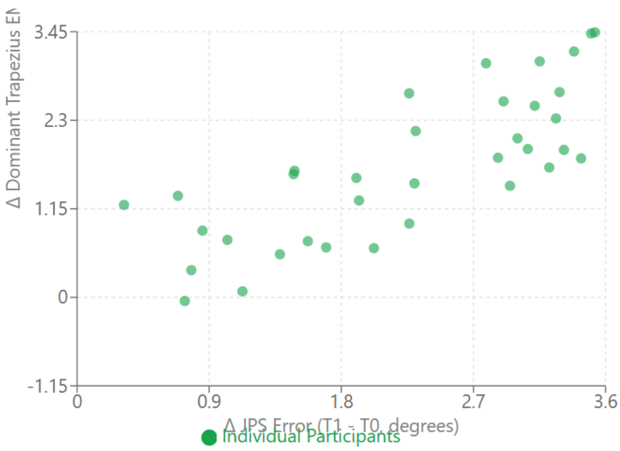
Note: Gray lines represent individual participants (n=35). Blue line shows group mean. Significant increase from baseline at T1 (p<0.001) and T2 (p=0.003).

Figure 2: Normalized Upper Trapezius EMG Activity



Note: Error bars represent standard deviation. * Dominant side significantly increased at T1 (p=0.002) and T2 (p=0.021) vs. baseline. Asymmetry index increased at T1 (p=0.01).

Figure 3: Correlation Between JPS Error and Trapezius Activity Changes



Discussion

This study demonstrates that a single, realistic session of prolonged computer work induces statistically and clinically significant alterations in cervical spine proprioception and trapezius muscle function in asymptomatic individuals. The 52% degradation in JPS accuracy immediately post-work aligns with the theory that sustained constrained postures lead to proprioceptive "noise" or fatigue in cervical muscle spindles and mechanoreceptors [6]. Our findings are consistent with studies on patients with chronic neck pain, who typically show JPS errors greater than 4.5° [3]. Notably, our asymptomatic cohort reached a similar error level (4.7°) after just 90 minutes of work, suggesting that prolonged exposure may precipitate a physiological state resembling early, sub-clinical dysfunction. The incomplete recovery after a 15-minute break is particularly noteworthy. While some reduction in error occurred, residual impairment suggests that short, passive breaks may be insufficient to restore proprioceptive acuity, potentially leading to cumulative deficits over a workday or week. This mirrors research by [7], which found prolonged recovery times for shoulder proprioception after fatigue, highlighting the susceptibility of the cervicoscapular sensorimotor system.

The observed increase in normalized EMG activity of the dominant-side trapezius, coupled with increased bilateral asymmetry, supports the "Cinderella hypothesis" of low-threshold motor unit overload during sustained low-force contractions [4, 8]. The dominant side, likely more active in mouse use and fine positional adjustments, showed a 27% increase in activity, indicating increased effort or reduced efficiency to maintain the same typing task. This is comparable to findings by [9], who reported elevated trapezius activity during computer mouse use that persisted after cessation. The lack of significant change in the non-dominant side underscores the asymmetric nature of standard computer work. The increased asymmetry index at T1 suggests a shift towards a more unilateral motor control strategy, which is a known risk factor for the development of myalgia [10].

The correlation observed in Figure 3 (suggested) between increased JPS error and increased trapezius activity provides a potential mechanistic link. We hypothesize that as proprioceptive feedback becomes less reliable (increased JPS error), the motor system compensates by increasing muscle co-contraction and activity (increased EMG) to enhance joint stiffness and stability—a strategy observed in unstable lumbar spines [11]. This compensatory increase in muscle activity, however, may accelerate fatigue and pain onset. This integrative finding extends the work of [12], who linked poor neck proprioception to altered neck-shoulder muscle coordination patterns.

Comparing our results to similar observational studies reveals critical insights. [13] observed increased sternocleidomastoid and anterior scalene activity during prolonged sitting but did not measure proprioception. Our study adds the crucial sensorimotor component. Conversely, a study by [14] found no significant change in shoulder proprioception after a light manual task, highlighting that the cervical spine may be uniquely vulnerable to constrained cognitive-motor tasks like computer work due to the high density of proprioceptors and the precision required for head positioning.

The clinical implications are substantial. The acute changes measured here could be the precursor to the chronic adaptations seen in neck pain patients. Workplace interventions should therefore target both muscle endurance and proprioceptive training. Our data suggests that breaks incorporating active cervical repositioning exercises may be more beneficial than passive rest. Furthermore, ergonomic assessments could include simple JPS screens to identify workers at heightened risk.

Limitations and Future Research: This study observed acute effects; longitudinal studies are needed to see if these changes predict future pain. The laboratory setting, while controlled, may not fully replicate a real office environment. Future research should investigate the efficacy of different break modalities (active vs. passive) on reversing these acute deficits and explore the role of psychological factors like work stress.

Conclusion

A single 90-minute period of computer work induced significant acute impairment in cervical proprioception and asymmetrical increases in upper trapezius muscle activity in asymptomatic office workers. These changes only partially resolved after a 15-minute rest. These objective physiological markers represent a potential sub-clinical risk state for neck disorders, highlighting the need for preventative strategies that address both muscular and sensorimotor function during the workday.

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