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Effects of postural and visual stressors on myofascial trigger point development and motor unit rotation during computer work

Jeffrey A. Hoyle [a,*], William S. Marras [b], James E. Sheedy [c], Dennis E. Hart [d]

[a] The Ergonomics Center of North Carolina, Edward P. Fitts Department of Industrial and Systems Engineering, North Carolina State University, 3701 Neil St., Raleigh, NC 27607, United States

[b] The Biodynamics Laboratory, Department of Industrial, Welding, and Systems Engineering, The Ohio State University, 1971 Neil Ave., 210 Baker Systems, Columbus, OH 43210, United States

[c] Vision Ergonomics Laboratory, College of Optometry, Pacific University, 2043 College Way, Forest Grove, OR 97116, United States

[d] Adena Health System, 272 Hospital Road, Chillicothe, OH, United States

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ABSTRACT

Musculoskeletal complaint rates are high among those performing low-level static exertions (LLSEs), such as computer users. However, our understanding of the causal mechanisms is lacking. It was hypothesized that myofascial trigger point (MTrP) development might be one causal mechanism to help explain these complaints and that static postural and visual demands may be contributing factors. Therefore, the purpose of this experiment was to examine MTrP development and the behavior of multiple parts of the trapezius muscle under postural and mental stress (represented by visual stress) conditions during computer work. Twelve subjects (six male and six female) were monitored for MTrP development via expert opinion, subject self-report, and cyclic changes in EMG median frequency across fourteen spatial locations. Results showed that MTrPs developed after one hour of continuous typing, despite the stress condition. Interestingly, both the high postural and high visual stress conditions resulted in significantly fewer median frequency cycles (3.76 and 5.35 cycles, respectively), compared to the baseline low stress condition (6.26 cycles). Lastly, the MTrP location as well as locations more medial to the spine showed significantly fewer cycles than other locations. Findings suggest that MTrPs may be one causal pathway for pain during LLSEs and both postural and visual demands may play a role in muscle activation patterns, perhaps attributing to MTrP development and resultant discomfort.

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1. Introduction

The nature of modern work is changing. Physically demanding jobs are now being replaced with many more service oriented jobs that require work at low levels of physical loading. More specifically, computer work at visual display terminals (VDTs) is becoming much more prominent in the workplace and at home. According to the Bureau of Labor Statistics (BLS), 77 million Americans use a computer at work. This represents over half of the total employed American public. In addition, with continual technological advances, future work trends indicate that this type of work is expected to represent an even greater percentage of jobs in the future (NRC, 2001).

Despite this shift, musculoskeletal complaint rates continue to be high among computer users. Studies have reported MSD prevalence rates of 20% to over 75% among these types of workers (Hsu and Wang, 2003; Ming et al., 2004). However, our understanding of the causal mechanisms leading to such high prevalence rates among computer users is lacking.

It is known that the physical demands for computer work are much different than those required during typical manufacturing and industrial tasks. Computer tasks typically require much lower levels of physical force and much more mental processing than industrial work. In terms of physical demand, computer work imposes low-level static exertions (LLSEs) on the musculoskeletal system. An important aspect of these types of exertions is that the muscle is rarely (if ever) able to relax completely (Jonsson, 1988); therefore, the duration of sustained contraction is thought to be a critical component for MSD risk. Originally, it was thought that these LLSEs could be maintained for an unlimited amount of time. However, experience and research may contradict this belief.

In the 1970s, static contractions of 15% MVC (maximum voluntary contraction) was thought to be the level at which these exertions could be held endlessly (Rohmert, 1973). Since then, other studies have claimed that lower static levels ranging from 0.5%

* Corresponding author. Tel.: +1 (919) 515 8400.
E-mail address: hoyle@TheErgonomicsCenter.com (J.A. Hoyle).

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to 5% MVC may still pose problems to workers (Jensen et al., 1993a; Jonsson, 1988; Veiersted et al., 1990). Still others suggest that fatigue and discomfort can develop at any contraction level (Mathiassen et al., 1993; Sato et al., 1984; Sjogaard et al., 1986). The point is that there is growing concern that LLSEs (at any level) pose risk to workers, but there is no consensus as to "how much" force can be maintained for "how long". This lack of consensus is believed to be due to the poor understanding of the underlying mechanisms through which the health effects occur.

In addition to physical demand, computer work also imposes high mental demands on users. Visual information must be processed, interpreted, and reacted to in a very short period of time, resulting in high cognitive demands on workers. Visual parameters such as glare, lighting, screen resolution, or text legibility may directly impact cognitive demands during computer work. However, it is not clear how these visual and mental demands might impact the musculoskeletal system, and translate into physical symptoms. Studies have shown that increased mental demand may result in greater muscle co-contraction (Finsen et al., 2001; Laursen et al., 2002; Leyman et al., 2004) and sustained muscle activation (Waersted and Westgaard, 1996). However, such results do not fully explain the casual pathway for pain and discomfort during computer work.

One potential pathway that may help explain musculoskeletal discomfort during computer work is through the development of myofascial trigger points (MTrPs). MTrPs are contraction "knots" or "nodes" that can form within a taut band of muscle or at myotendonous junctions that are believed to be a source of pain. Although the exact causal mechanisms through which this pain occurs are not well understood, many believe that MTrPs cause unusually high oxygen demands to maintain contraction, creating an area of hypoxia. With time, fibers under continual contraction in an oxygen starved environment eventually exceed their tissue tolerance, resulting in microtrauma. Such microtrauma is followed by a local inflammatory response that is believed to play a crucial role in elevated pain response (Simons, 1997, 2004; Simons et al., 1999). In an effort to distinguish MTrPs from other musculoskeletal disorders, the following diagnostic criteria have been agreed upon by several researchers (Alvarez and Rockwell, 2002; Mense et al., 2001; Simons et al., 1999):

- The pain is typically muscle-oriented.
- MTrPs are hypersensitive and applied pressure produces or aggravates the pain and tenderness.
- The pain is reproducible and MTrPs are consistently found in the same part of the muscle for a particular person. The same amount of pressure on the contra-lateral muscle, if not involved in the syndrome, does not produce pain or tenderness.
- Stimulation of the MTrP produces pain that is felt locally, is referred in a pattern distant from the TrP, or both. The referred pain and tenderness are projected in a predictable pattern.
- Hardening of a taut band of muscle fibers passing through the MTrP in a shortened muscle can be palpated.
- When the MTrP is stimulated by snapping palpation or needle penetration, a local twitch response of the taut band of muscle is produced.
- Injection of a local anesthetic into the MTrP promptly eliminates the pain, tenderness, and other signs and symptoms.

While the above diagnostic criteria are commonly cited, there is no true gold standard for MTrP diagnosis. Therefore, more studies are needed to better understand their etiology, which may lead to improved diagnosis and treatment.

The neck and shoulders, particularly the trapezius muscle, are common sites for MTrPs (Simons et al., 1999; Sola et al., 1955). Although the exact causal mechanisms are largely unknown, MTrPs are common among workers exposed to LLSEs (Mense, 2002; Rachlin, 1994; Simons, 1997) such as computer work. Prevalence rates among such workers have ranged from 21% to 93% (Mense et al., 2001). Despite such prevalence rates, MTrPs have received little attention by researchers and ergonomists as potential sources of pain for computer users.

While MTrPs have been explained as purely "electrophysiological phenomenon" (Gerwin, 1994), there are very few studies in ergonomics or biomechanical literature that have investigated electromyography (EMG) and trigger point development. Those that have studied MTrPs with EMG have primarily used invasive techniques (wire or needle electrodes) to assess muscle activity (Hubbard and Berkoff, 1993; McNulty et al., 1994; Simons et al., 2002). However, the methodological approach of such studies is controversial as it unclear whether abnormal electrical activity was the result of the MTrP or the result of the needle electrode inserted into the muscle. Therefore, less invasive surface EMG studies are needed.

Only recently has a study been conducted to investigate MTrPs with surface EMG under low-level static conditions (Treaster et al., 2006). This study measured MTrP development and EMG at a single location in the upper trapezius while subjects performed computer tasks. Interestingly, the study found that MTrPs developed after continuous typing for just 30 min and the level of visual demand affected this development as well as muscle activation patterns in the upper trapezius muscle (Treaster et al., 2006). However, additional studies are needed to support this claim and understand the nature of this pathway.

The purpose of this experiment was to examine the development of MTrPs and discomfort under LLSE task conditions. We hypothesized that postural stressors and mental demand (represented by visual stress) might independently impact MTrP development during computer work. MTrP development was monitored via cyclic changes in median frequency recorded from an EMG array on the trapezius and established independently by a myofascial specialist and subjectively rated for pain intensity by subjects.

2. Methods

2.1. Subjects

Twelve subjects (6 male, 6 female; mean = 23.4 years, range = 20–30 years) were recruited from the university student population to participate in the study. Accepted subjects had no history of upper extremity disorders, no major ocular pathology, and had a minimum touch typing ability of 30 words per minute. Subjects who reported poor sleep quality or intense physical activity in the preceding 24 h were excluded from the study. Subjects that could not be palpated for a MTrP in the upper division trapezius by the clinician's pre-experiment screening were excluded. Subjects with MTrPs in the trapezius that could not be released by the clinician during the pre-experiment screening were also excluded. Testing protocol was approved by the University's Institutional Review Board.

2.2. Protocol

The study was a repeated measures design with three levels of workstation condition:

- Baseline – low visual stress/low postural stress (VL/PL)
- High visual stress/low postural stress (VH/PL)
- Low visual stress/high postural stress (VL/PH)