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The role of muscle activity and mental load in the development of pain and degenerative processes at the muscle cell level during computer work

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Introduction

The prevention of muscle disorders in the operation of computer input devices, PROCID, is a European Concerted Action Project which held an international symposium in Denmark in November 1999. This issue of the European Journal of Applied Physiology contains 16 contributions to the symposium, some presenting new material, others being reviews. These contributions address a number of topics that were deemed to be of particular interest in view of the specific aims of the PROCID. These include:

1. Motor control patterns in humans including methodological aspects (five papers)
2. Motor unit activity during low force contraction and responses to pain and fatigue (four papers)
3. Muscle activity and the effects of psycho-physiological stress (three papers)
4. Mechanisms underlying muscle damage (four papers).

The present editorial is an attempt to put these into a general perspective, thus showing the tight links among them, as well as illustrating the general scope of the PROCID. The authors are very much obliged to the European Journal of Applied Physiology for judging the topic as being sufficiently important to deserve publication.

Background

Chronic pain in the musculoskeletal system is an adjunct to, or a result of, many different types of exposure during working life, including exposure to mechanical and mental requirements or loads. The majority of these pain syndromes commonly related to the occupation have focused on nerve entrapment and inflammatory reactions in tendinous tissues (Hagberg et al. 1995), where the underlying mechanisms causing pain are comparatively well understood. However, with respect to muscle pain this is not the case, even though chronic muscle pain in recent epidemiological studies has been shown to be prevalent in many occupations. For instance, muscle pain in the shoulder has been found to have high prevalence in welders as well as in computer operators, which illustrates the multidimensional character of the problem (Herberts et al. 1981; Hünting et al. 1981). Pain localized in muscle may not always be based on events within the muscle itself, but may be caused by processes in adjacent tissues, for instance in tendons or ligaments. Sometimes muscle pain may originate in other somatic structures, giving rise to so-called referred pain. However, in the present context we focus on pain that originates within the primary muscle itself in relation to muscle activity and mental load.

Muscle activity is required for performing physical activity at work, during sports, leisure time, etc. and is generally considered to be health promoting. This is because mechanical loading has been said to be essential to ensure the viability of the musculoskeletal tissues (Hargens 1986). Nonetheless we also consider muscle activity to play a significant role in the development of musculoskeletal disorders. This is plausible for tasks with high force requirements, possibly causing mechanical overloading of the tissues, and thereby obviously being causally related to disorders such as sports injuries and occupational accidents. Low force requirements do not constitute equally plausible risk factors leading to muscle disorders; however, a more recent Cinderella
hypothesis has proposed that single muscle fibres may be intensely active at force levels considered to be low for the muscle as a whole (Hägg 1991).

Mental activity is associated with activation of various physiological systems, including the muscles. Such bodily reactions are important for successfully coping with various environmental demands and for the protection and restoring of the body and involve, for example, a decrease in the blood supply to the inner organs and an increase to the muscles and the brain. This response provides resources for muscle effort and for efficient mental performance, but is also assumed to create a link between mental demands and somatic illness. As with heavy physical demands, intense stressors were, according to earlier stress models, assumed to be the major cause of stress-related illness. However, according to more recent models of stress and health, over- as well as under-activity of the allostatic systems has been assumed to contribute to health problems (McEwen 1998).

A dynamic stress response, with rapid activation of the allostatic systems in response to a stressor followed by rapid deactivation when the stressor ends, is considered an efficient and healthy way of coping with environmental stress.

Computer work is characterized by low physical and mental exposure levels but none the less extensive health problems have been documented (Bammer 1987; Jensen et al. 1998; Punnett and Bergqvist 1999). Since we can envisage an increasing use of this technology in our working life and leisure time there is an urgent need to understand the mechanisms underlying the development of these disorders. Such knowledge is a prerequisite to the introduction of lasting effective preventive strategies. The inter relationship between the different mechanisms is illustrated in Fig. 1.

**Muscle activation pattern**

The prevailing hypothesis is that prolonged activity of single muscle fibres may cause degenerative changes in the muscles. In support of this hypothesis detailed knowledge is required on recruitment patterns of motor units (MU), which are the smallest functional units in the muscle to be activated. Delicate techniques have been required for recording such activity and ongoing development as well as evaluation of these methods are required (Disselhorst-Klug et al. 2000; Pilegaard et al. 2000). It has been shown that descending input from the motor cortex in the central nervous system (CNS) to the MU may be modified by afferent input from the peripheral tissues, for example during fatigue (Taylor et al. 1996), and that voluntary activity does not imply that reflexes are not involved (Chalmer and Bawa 1997). For this reason some papers in the present issue have addressed this area (Bawa et al. 2000; Taylor et al. 2000)

**Fig. 1** Diagram showing the relationships between the various mechanisms that may be involved in the development of occupational muscle disorders