Philosophy and muscle mechanics in human-chair-computer interaction; disorders preventive approach

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ABSTRACT

Innovation and technical change often do produce workplace pain [1]. Looked at from a medical perspective this is not a new phenomenon. As long ago as 1685 Giovanni Alfonso Borelli, the father of modern biomechanics stated: "muscular tensions inevitably have to be involved in holding posture"[2]. And in 1700 Bernardo Ramazzini, the father of occupational medicine observed about neck and shoulder complaints in clerks *"Yet tis certain that in each City and Town vast Numbers of Persons earn their Bread by writing. The Diseases of Persons incident t o that Craft arise from three Causes: First, constant Sitting, secondly the perpetual Motion of the Hand in the same Manner, and thirdly, the Attention and Application of the Mind"*[3]. These great minds came to these truths purely as a consequence of observing, palpating, and inspecting. In their day there were no tools for objective measurement. In recent times space medicine has given important insights into the significance and effect of gravity on the human musculoskeletal system, a number of devices have been developed to gain better understanding of how muscles function, and it has been established that sitting for long time is in itself a risk factor for developing neck pain.

Keywords: sitting, neck and shoulder pain, muscle tension, gravity, support function, workplace prevention

INTRODUCTION

Homo sapiens evolved to be a hunter-gatherer, on the move. If we were to imagine seeing a whole human lifetime flash past in an hour-long movie, the most noticeable activity would be the constant change from standing to sitting and lying. The human mammal is quite extraordinary in the sense that we daily change the direction of our longitudinal axis relative to our most significant environmental factor, namely gravity. From morning till evening our longitudinal axis has to be supported upright by the musculoskeletal system against the force of gravity. At night the situation changes drastically when we lie down, thus almost eliminating the effect of gravity on the skeletal muscles. We know that the stiffness of the muscles diminishes in that position [4].

Given that we spend a third of our lifetime lying down, the importance of this change in axis in providing a natural recovery from the stresses on the musculoskeletal system imposed by gravity cannot be overemphasised.

Thanks to the development of the electromyograph (EMG), the magnetic resonance elastograph (MRE) and the Myoton, we now have tools with which to measure and describe muscular activity.

EMG produces a record of electrical activity in the muscle by means of an electrode inserted into the muscle or placed on the skin. Normal muscle is seen to be electrically silent when at rest, but when active an electrical current is generated. MRE is a medical imaging technique, which displays the relative stiffness of different regions inside the body. It provides high contrast between soft and hard tissue.

MUSCLE PROPERTIES

In this paper we present results of the Myoton (see Fig 1.), a portable, hand-held non-invasive device that induces and records the damping oscillation of soft biological tissues [5]. From that curve parameters are calculated that characterise muscle tone, elasticity and stiffness.

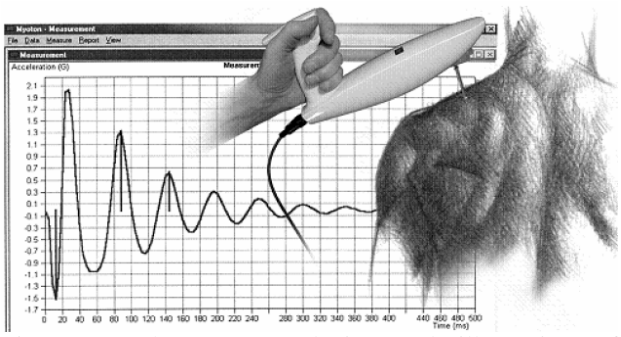

Figure 1. The Myoton device and illustration of myometric measurements of UT muscle in sitting position. [Reprinted with permission of Viir R, Laiho K, Kramarenko J, Mikkelsson M. Repeatability of trapezius muscle tone assessment by a myometric method. Journal of Mechanics in Medicine and Biology Vol. 6, No. 2 (2006) 215–228 and © World Scientific Publishing Company

In our most recent study [6], using the Myoton device, we have demonstrated that tone and stiffness in the upper trapezius muscle increased by up to 20% in the sitting position as contrasted with the lying position (see Figures 2. and 3.)

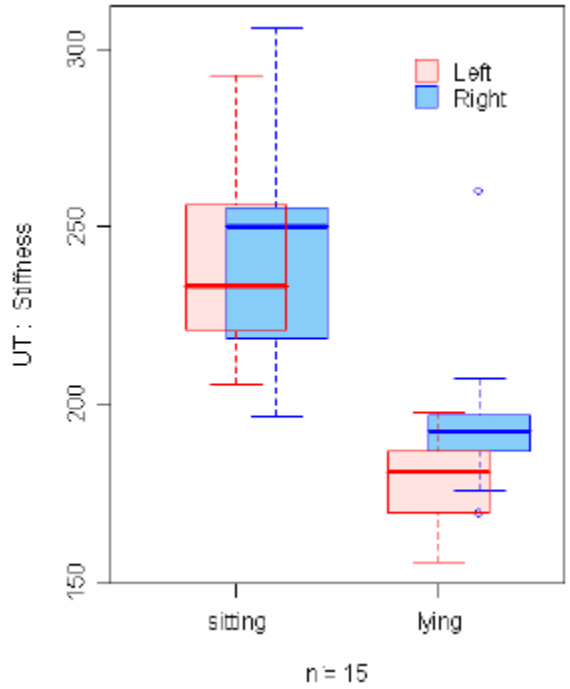

Figure 2. Box-plot representing change in muscle stiffness. [Reprinted with the permission of Viir R, Virkus A, Laiho K, Rajaleid K, Selart A, Mikkelsson M. Trapezius muscle tone and viscoelastic properties in sitting and supine positions. SJWEH Suppl. 2007;(3):76-80 and the Scandinavian Journal of Work, Environment & Health.]

This would seem to bear out the contention that even in passive sitting our musculoskeletal system has to work against gravity. Ours was a small pilot study, and though it held up statistically, it is highly desirable that a larger study be held to validate these results, particularly because of their potential significance to everybody working at PCs.

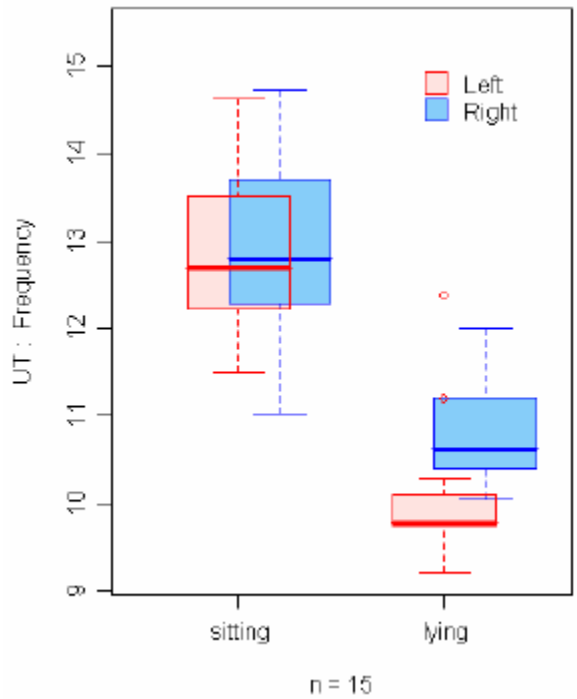

Figure 3. Box-plot representing change in muscle tone. [Reprinted with the permission of Viir R, Virkus A, Laiho K, Rajaleid K, Selart A, Mikkelsson M. Trapezius muscle tone and viscoelastic properties in sitting and supine positions. SJWEH Suppl. 2007;(3):76-80 and the Scandinavian Journal of Work, Environment & Health.]

DISCUSSION

It has been established by Ariëns with colleagues [7] that just being seated for 95% of one's work period is in itself a risk factor in developing neck pain. From a biomedical perspective we would go beyond that and say that so sedentary a way of life is in itself dangerous to humans (and that is without reference to the current plague of gross overweight among so many of us). Indeed, there is alarming evidence to suggest that too much sitting makes us prematurely old, as key pieces of DNA telomers shorten more quickly in people having a sedentary lifestyle. This could signify faster cellular ageing [8]. And who wants that? We must be mindful of our individual responsibility to maintain optimal musculoskeletal health in this new, strangely addictive work environment.

To do this will require the cooperation of two groups. Firstly the designers of the Human Computer Interface. A simplistic view would hold that they, besides ignoring the significance of prolonged sitting, are putting their efforts into making PCs ever easier for us to use. The biomedical perspective would see this as heading in quite the wrong direction. In order to maintain good musculoskeletal health we need less sitting and more walking every day.
But do we need to stay ignorant of each others' insights, or even antagonistic? By pooling our awareness might we not arrive at innovative strategies to deal with this very serious problem? Could one, for instance, use the computer itself to monitor the condition of the user and to develop software to advice the user when a break should be taken? Might we consult psychologists about how to couch such advice in a way that is attractive enough for the user to ensure compliance?

When in our first pilot study we in Rheumatism Foundation Hospital perceived the significance of muscular strain involved in sitting and standing we extended our investigations. What would be the best way to ameliorate this muscular stiffness? In the light of our awareness of the near-zero effect of gravity [4] when lying down, that would clearly seem to be a possible strategy. But in what manner, how often, and for how long? What if we were to combine reducing the support function loading with specific movement? The patients were asked to lie supine, make rhythmic walking movements with their legs, alternating this with unchallenging simple rotation of their shoulders.

We found out that as little as two minutes per hour of such practice allowed the muscles to recover their visco-elastic properties within the period of four weeks [9]. Now we propose regular horizontal activities to people with widespread pain called fibromyalgia because muscle relaxation difficulties is their common problem [10].

The second group whose cooperation is vital in seeking to promote good musculoskeletal health is, of course, that of the employers. The strongest association of neck and shoulder symptoms is with the duration of the computer work without breaks [11]. Melhorn et al state that American businesses face huge costs for work related musculoskeletal pain, but that employers have been reluctant to embrace the benefits of workplace intervention [1]. It is likely that this would also be the case in many other parts of the world.

Would it still be so if a simple, cheap, easy to administer, not very time-consuming preventive strategy, such as described above, were to be confirmed to be effective? All it needs is a few mats and some kind of orderly procedure to use them for two minutes per person per hour.

Again, in order to best demonstrate this we need cooperation from the computing industry, as a larger study needs to be undertaken to verify our findings. For this manpower, money to pay them, and a larger cohort of subjects needs to be made available. We might also be able to work together to make recreational exercise of the unusual kind we propose palatable to employees across the spectrum of genders, creeds, and cultural practices. Prevention is always better than cure. The simplicity and cheapness of the method are recommendations in themselves. The resultant gains in health and productivity are surely worthwhile goals to aim for.

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