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Postural dynamism during computer mouse and keyboard use: A pilot study

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ABSTRACT

Prolonged sedentary computer use is a risk factor for musculoskeletal pain. The aim of this study was to explore postural dynamism during two common computer tasks, namely mouse use and keyboard typing. Postural dynamism was described as the total number of postural changes that occurred during the data capture period. Twelve participants were recruited to perform a mouse and a typing task. The data of only eight participants could be analysed. A 3D motion analysis system measured the number of cervical and thoracic postural changes as well as, the range in which the postural changes occurred. The study findings illustrate that there is less postural dynamism of the cervical and thoracic spinal regions during computer mouse use, when compared to keyboard typing.

1. Introduction

Spinal pain is common amongst computer users (Janwantanakul et al., 2008; Smith et al., 2009). Spinal pain refers to pain experienced in the cervical, thoracic or lumbar regions. Of these, the most prevalent areas of pain among computer users are the upper thoracic and cervical spinal regions (Côte et al., 2008). When considering the increasing computer use worldwide, this burden of computer related spinal pain, particularly in the thoracic and cervical regions, is of public concern (Carroll et al., 2008; Côte et al., 2008).

Risk factors associated with computer related thoracic and cervical pain is a topical research area (Andersen et al., 2011). These risk factors include, but are not limited to, gender, work stress, type of computer used, psychometrics, duration and frequency of computing, and posture (Andersen et al., 2011; Da Costa and Vierra, 2010). Although it is acknowledged that risk factors follow a multifactorial causal pathway, researchers often follow a pragmatic approach by investigating a specific individual risk factor. Posture is a potentially modifiable risk factor and knowledge about the relationship between posture and computer related musculoskeletal pain is thus clinically meaningful. Brink and Louw (2013) showed that the impact of sitting posture on upper quadrant (cervical, upper thoracic and upper limb) musculoskeletal pain remains controversial. Further research into postural risk factors of computer related thoracic and cervical pain is therefore needed.

Research related to sitting computing posture has mainly focussed on postural alignment by measuring spinal position or angles (Brink and Louw, 2013, Marcus et al., 2002). The underlying rationale is that if a spinal position is maintained for a prolonged period of time, it will lead to micro-damage of soft tissue structures and consequent pain (Tittiranonda et al., 1999; Troussier et al., 1999; Ariens et al., 2001; Straker et al., 2010). While these studies have provided some insight into the relationship between computing spinal position and musculoskeletal pain, to our knowledge no published research has as yet investigated the number of three dimensional (3D) spinal movements (postural dynamism) during computer tasks.

Postural dynamism refers to the number of frequent involuntary postural or movement changes whilst sitting. Dynamic chairs are designed to encourage postural changes during sitting, which may influence postural dynamism and spinal pain (Lewis and Fowler, 2009). A systematic review by O'Sullivan et al. (2012) indicated a lack of evidence to support postural dynamism as a stand-alone approach in the management of computer related lumbar pain, as the nature of spinal pain is multi-dimensional. However, in an isolated study of 105 subjects (aged 8–12 years), an increase in postural dynamism was shown to decrease spinal pain in scholars (Geldhof et al., 2007). Increased postural dynamism whilst sitting is associated with less intervertebral disc compression and reduced

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loss of disc height due to radial bulging in the lumbar region (Lewis and Fowler, 2009). It is possible that a similar response may occur in the cervical and thoracic spine with increased postural dynamism. This underlying mechanism may partially explain why increased postural dynamism is postulated to reduce spinal pain.

Postural dynamism (measured as the number of postural changes in cervical and thoracic angles) varies between computer tasks (Van Dieën et al., 2001). Van Dieën et al. (2001) analysed only two-dimensional (2D) sagittal plane trunk kinematics, implying that there is currently no knowledge about postural dynamism in the transverse and coronal planes. Three-dimensional (3D) analysis adds to knowledge since postural dynamism is described in all three cardinal planes. 3D analysis thus provides an enhanced reflection of how postural dynamism occurs in reality. The specific aim of this study was to explore 3D postural dynamism during two common computer tasks, namely mouse use and keyboard typing. In addition, we describe a new method of postural dynamism where the number of changes in cervical and thoracic angles is analysed over a period of computing time (Van Niekerk et al., 2014).

2. Methodology

2.1. Participant recruitment and selection

Twelve freshman physiotherapy students volunteered to take part in the study. The exclusion criteria included a history of spinal or neurological pathology, a body mass index ratio higher than 25 and/or a high waist-hip ratio less than 0.8 in females and 0.9 in males, as increased skin folds may obscure markers.

2.1.1. Sample size calculation

We used G-Power (version 3.1.7) sample size calculator to calculate sample size. A sample size that seven subjects were required to detect a statistical difference between the two computer tasks (typing and mouse clicking) for an effect size of 1.66, using a paired t-test, at least (alpha level of 0.05).

2.2. Motion analysis

2.2.1. Motion analysis system

The Vicon Motion Analysis system (Vicon, Oxford, United Kingdom) which consists of eight (either wall-mounted or tripod-mounted) T-10 MX cameras was used to film the participants as it has demonstrated high accuracy and reliability (Ehara et al., 1995) and has less than a 1.5-degree error (Richards, 1999).

The Vicon system detects retro-reflective markers in a capture volume and reconstructs these marker positions in three dimensions. A biomechanical model is used to calculate spinal angles based on marker positions. Data processing was done using Nexus software.

2.2.2. Laboratory set-up and preparation

A custom-made desk with a U-shaped foot piece was used to optimise marker visibility (Fig. 1). The participant was seated on a regular typist's chair with the backrest removed to enable visibility of the posterior anatomical landmark markers. A flat-screen computer monitor, computer mouse, keyboard and a ball and cup were positioned at marked areas on the desk. The heights of the chair and/or monitor were adjusted individually for each participant, so that their hips and knees were at a ninety degree angle and their gaze angle was approximately 30° to the horizontal (Cook and Burgess-Limerick, 2003). A footrest was used where necessary to improve the foot to floor contact (Fig. 1).

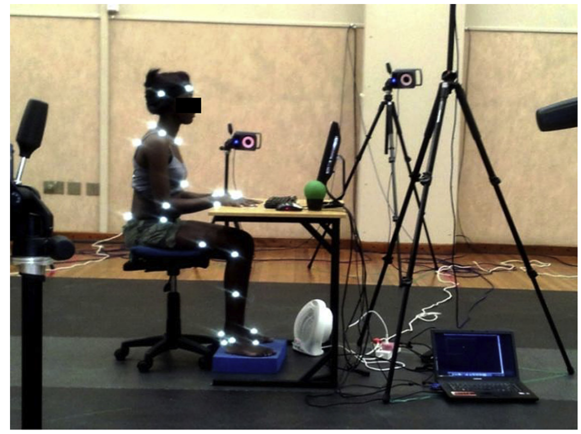

Fig. 1. Subject positioning.

2.2.3. Anthropometric measurements and marker placement

The Conventional Gait Model was used as this provided the angle output sought for the analysis undertaken in this research (Baker and Rodda, 2003; Davis et al., 1991). Although the Conventional Gait Model had not yet been validated for sitting, its established validity for standing and the likely transferability of the model to sitting, enabled the same model to be used.

Prior to data capture, anthropometric measurements were done according to the Conventional Gait Model, currently an industry standard in motion analysis (Lind et al., 2013; Van der Krogt et al., 2012). These measurements included the height, weight, leg length, shoulder offset as well as the widths of the ankle, knee, elbow and wrist. Marker placement was done according to the Full-body Conventional Gait Model Marker Placement Protocol of the Stellenbosch University FNB-3D Movement Analysis Laboratory. Although the Full-body Conventional Gait Model Marker set was used, we only report on the markers relevant to this study (Table 1). All anthropometric measurements and marker placements were done by a physiotherapist with training and experience in marker placement and a sound understanding of the full body Conventional Gait Model.

2.2.4. Spinal angles of interest

The output of the angles of interest (cervical and thoracic angles) was calculated from the YXZ cardan angles derived by comparing the relative orientations of the two segments being measured. This does not affect the Cardan angle calculation of the other angles since the flexion angle is the first in the rotation sequence. The progression angles of the thorax and cervical spine were the YXZ Cardan calculated from the rotation transformation of the subject's Progression Frame, for the trial onto each segment orientation.

Table 1
Marker placement protocol of stellenbosch university gait laboratory.

Segment	Section	Landmarks[a]
Head	Front of Head	Approximately over temples
	Back of Head	In horizontal line to front markers
Torso	Clavicular	Suprasternal notch
	Sternal	Xiphoid process
	Right Back	Approximate centre of scapula (right side only)
	C7	Spinous process of C7
	T10	Spinous process of T10

[a] All head and peripheral landmarks with exception of Right Back is positioned bilaterally.