Manual Therapy 19 (2014) 197–202

Contents lists available at ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Sitting bodily configuration: A study investigating the intra-tester reliability of positioning subjects into a predetermined sitting posture

Vasileios Korakakis [a,b,*], Vasilis Sideris [a,b], Giannis Giakas [a,b]

[a] Faculty of Physical Education and Sport Sciences, University of Thessaly, Karyes 42100 Trikala, Greece
[b] CE.RE.TE.TH, Trikala, Greece

ARTICLE INFO

Article history:
Received 30 March 2013
Received in revised form
23 December 2013
Accepted 8 January 2014

Keywords:
Sitting posture
Spinal posture
Intra-tester reliability
Sagittal angles

ABSTRACT

Sitting posture predominates in lifestyle and workplace, but quantitative postural designation is limited due to divergence of methodology used in the studies.

To date, no study has investigated the upper body's habitual or a predetermined sitting posture in healthy individuals assessing together pelvis, spine and head. The objectives were (i) assessment of intra-rater reliability of positioning subjects to a lordotic sitting posture and (ii) comparison of habitual sitting posture (HSP) with the lordotic posture. Another objective was to synthesize and propose an improved 3D model for pelvis, trunk and head to assess quantitatively the postural sagittal configuration.

A single session test-retest design was employed. After power calculations 25 subjects were recruited. A repeated measure ANOVA revealed significant differences between HSP and the predetermined posture used in the study. Intra-rater reliability was analysed used the intra-class correlation coefficient (ICC) and also standard error of measurement (SEM) and smallest real difference (SRD) were calculated. The ICC values for all angles ranged from 0.85 to 0.98 indicating almost perfect agreement. The SEMs for all angles ranged in degrees from 0.65 to 1.50 and the SRDs from 1.80 to 4.16.

This study provides the most specific sagittal measurement of surface spinal curves, head and pelvis position, in reference to a lordotic seated posture. The clinical significance of this study is reinforced by the fact that postural assessment is conducted by body surface evaluation. The results regarding reliability and SEMs established that healthy individuals can be reliably positioned in an upright lordotic sitting posture.

1. Introduction

The time spent in a sitting posture is increasing steadily in modern society (Rhodes et al., 2012). Although sitting predominates in lifestyles and the workplace, the definition of the optimal sitting posture is debatable in the literature. An extensive review argued that proponents of both lordosed and kyphosed sitting posture use similar epicheiremas with contradictory conclusions (Pynt et al., 2001). On top of that, consistent evidence stresses the recommendation for interruption from sustained posture. Any position lordosed or kyphosed maintained for a period of time without interruption can lead to discomfort and symptoms due to "stress concentration" on spinal tissues (Adams et al., 2006; Womersley and May, 2006).

From a clinical perspective, postural positioning and training are integral parts of musculoskeletal assessment and treatment of low back and neck pain (Poitras et al., 2005). Although a sustained lordotic sitting posture may exceed the endurance capacity of the lumbar multifidus muscle (van Dieën et al., 2009), clinical studies have shown that such an intervention can impact spinal symptoms (Williams et al., 1991; Pillastrini et al., 2010) and activate key postural muscles of the lumbar and cervical spine (Claus et al., 2009a; Falla et al., 2007).

Postural education does not focus only on one segment of the spine (McKenzie and May, 2003, 2006). Furthermore, evidence indicates that spinal seated posture is driven by the position of the pelvis (Dunk et al., 2009) and lumbar curve configuration can affect cervical muscles' activation (Falla et al., 2007). To evaluate in research and clinical settings the process of postural correction and education, it is essential to synthesize and improve existing postural models to assess the overall superior body seated posture and provide positional data between and within body segments.

* Corresponding author. Hanion 15-17, Agia Varvara, Athens, TK 12351, Greece. Tel./fax: +30 2105691131 (office), +30 6977450993 (mobile).
E-mail address: vkorakakis@hotmail.com (V. Korakakis).

1356-689X/$ – see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.math.2014.01.001

In a number of studies, researchers positioned or trained subjects in a predetermined posture (O'Sullivan et al., 2002, 2006, 2010; Falla et al., 2007; Claus et al., 2009b; Caneiro et al., 2010) with some reporting intra or inter-tester reliability (O'Sullivan et al., 2002, 2010; Caneiro et al., 2010). The usage of facilitation in postural training is essential and is used extensively in clinical research (Falla et al., 2007; Claus et al., 2009a; Caneiro et al., 2010) as it is evident that subjects are not able to imitate postures with different curve directions in thoracic and lumbar regions without manual facilitation (Claus et al., 2009b). In order to assess the feasibility of reproducing a spinal curve mostly occurring at the lumbar spine (lordosis) (Claus et al., 2009b) and affecting the whole superior body's configuration, it is clinically important to examine the ability of individuals to adopt an upright lordotic repeatable seated position with manual facilitation from a therapist.

Accurate positional data can be derived from several biomechanical measurement tools (Brink et al., 2011). Reflective markers adhered to the skin over specific bony landmarks are used to quantify spinal curves and assess spinal posture (Edmondston et al., 2007; Claus et al., 2009a,b; Caneiro et al., 2010). These techniques have been validated against magnetic resonance imaging (Mörl and Blickhan, 2006) and radiography (Gadotti and Magee, 2013). In addition, skin surface measures are relevant to clinical practice, as posture assessment and training are based generally on body observation (Claus et al., 2009b).

To date, no study has investigated the superior body's habitual or predetermined lordotic unsupported sitting posture in healthy individuals assessing pelvis, spine and head simultaneously. Several studies have been conducted regarding seated posture, but positional data and sagittal angles in the majority of research designs have been narrowly defined to discrete segments of the superior body (for example only the lumbar spine and head).

The main objectives of the present study were (i) to assess the intra-rater reliability of an examiner to facilitate and position subjects to a predetermined lordotic sitting posture and (ii) to compare the participants' habitual sitting posture (HSP) with this predetermined lordotic posture. Another objective of the study was to synthesize and propose an improved 3D marker-based model for the pelvis, trunk and head for the quantitative assessment of the superior body's postural sagittal configuration. The proposed marker-based model and the reliability testing in subjects' positioning will link qualitatively and quantitatively this lordotic sitting posture. The significance of the present study is reinforced by the limited quantitative data regarding a qualitatively defined lordotic sitting posture.

2. Methods

2.1. Subjects

Twenty-five healthy university students (sports science) volunteered in this institutionally approved study and provided written informed consent. The group included 13 males (mean $\pm$ SD of age 24.5 $\pm$ 5.1 y; mass 72.7 $\pm$ 8.6 kg; Body Mass Index (BMI) 22.8 $\pm$ 2.4) and 12 females (age 23.3 $\pm$ 4.0 y; mass 57.3 $\pm$ 8.6 kg; BMI 19.8 $\pm$ 2.3). Participants had full and asymptomatic range of motion of the spine (cervical, thoracic and lumbar) and pelvis, confirmed by physical examination conducted by an experienced musculoskeletal physiotherapist. Exclusion criteria were a BMI greater than 28, or previous postural control training.

2.2. Equipment

Kinematic data were collected with a 10 camera T-40 Vicon MX system (Oxford, UK), sampling at 100 Hz. An ultrasound scanner (Telemed, Lithuania) was used to identify all body anatomical landmarks apart from the head.

2.3. Procedures

2.3.1. Subject preparation and marker placement

Each subject was suitably disrobed to allow skin marking with ink over the anatomical landmarks for placing the reflective markers. All landmarks were located by manual palpation, marked by an experienced physiotherapist and verified by a second investigator. Furthermore, by using an ultrasound scanner (10 MHz linear transducer) these landmarks were confirmed (apart from the head) according to methodology previously described (Kilby et al., 2012).

Sixteen 14 mm reflective markers were placed over the marked anatomical landmarks (Fig. 1a,b) and were firmly secured using double-sided adhesive tape. For attachment of the posterior body markers, subjects were placed in a prone position so that the skin surface and the designation of the spinal curves were closer to the neutral spinal position (Claus et al., 2009b). For the attachment of the anterior body markers subjects were standing erect and for the head markers subjects were comfortably seated.

The model that was created and the markers used were derived, modified and synthesized from numerous studies examining human posture and focusing on segments of the upper body (Szeto et al., 2002; Edmondston et al., 2007; Claus et al., 2009a,b; Kuo et al., 2009). We selected the most prominent bony landmarks of the pelvis, torso and spine. The boundary between the thoracic and lumbar regions was defined as being located at the T10 vertebral segment for two reasons according to Claus et al. (2009a), who stated that "facet joint orientation and spinal curves in standing can transition as proximally as T10." Markers were applied to the pelvis, bilaterally over the anterior and posterior superior iliac spines, to the posterior superior body over the C7, T5, T10, L3 and S2 spinous processes and the right scapula and to the anterior superior body over the sternal notch and xiphoid process (Szeto et al., 2002; Edmondston et al., 2007; Claus et al., 2009a). Furthermore, markers were adhered to the head bilaterally over the lateral margin of the orbit (Edmondston et al., 2007), over the external occipital protuberance by using an elastic band and on the main protuberance of the forehead between the eyebrows (Szeto et al., 2002; Caneiro et al., 2010). In the cervical spine only C7 was used because the assumption that the surface curve is the same as the vertebral curve is not supported by the literature (Refshauge et al., 1994). Given that the lumbar posture is driven by the position of the pelvis (Dunk et al., 2009), the posture model for the head segment was based on a Cartesian co-ordinate system embedded on the segment, in order to avoid contamination of the data from the relative position of the other segments.

2.3.2. Experimental protocol

Prior to testing, the subjects were assisted in moving through their available spinal, pelvic and head range of motion, in order to become accustomed with the limitations of the specific posture and the sensation of the adhered markers and to ensure the fixity of the reflective markers.

The subjects sat unsupported on a stool, the stool height was adjusted to the height of their popliteal crease and a goniometer was used in order to accommodate 90° between hips and knees and ankles at plantargrade. Their feet were placed shoulder width apart with hands resting on the thighs. Immediately after the subjects were instructed to relax and sit as they usually do. The adopted posture was covertly recorded for 10 seconds and this recording was defined as their HSP, as in previous studies (Edmondston et al., 2007; O'Sullivan et al., 2010). Prior to the positioning from the