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HUMAN POSTURE

Sagittal evaluation of usual standing and sitting spinal posture

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Summary Postural rehabilitation often plays an important role in the management of non-specific low back pain. While cervical and lumbar correlations have been demonstrated previously, the different role of the pelvis and the thoracic spine for postural control in sitting and standing remains unclear. The aim of this study was to investigate postural correlations between all spinal regions in standing and sitting. Based on digital photographs eight postural angles were analyzed in 99 young healthy persons. Pearson correlations between different postural angles were calculated. In sitting pelvic tilt demonstrated mostly medium correlations with five out of seven other postural angles, compared to three in standing. In standing trunk angle showed five out of seven mostly medium correlations with other regions compared to four out of seven in usual sitting. The low and different correlations suggest a large between-subject variability in sagittal spinal posture, without the existence of any optimal sagittal posture.

Introduction

Since alterations of spinal curvatures during static standing and sitting postures have been demonstrated to be associated with higher mechanical loading, neutral spinal alignment is regarded as optimal loading. Indeed, it has been suggested that non-neutral spinal postures play an important role in the development and maintenance of

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postural related spinal pain. Silva et al. (2009) demonstrated that an increase in forward head posture during standing was associated with chronic non-traumatic neck pain. More anterior pelvic rotation was associated with increased lumbar lordosis, chronic low back pain (Evcik and Yucel, 2003) and patellofemoral joint pain (Tsuji et al., 2002). Different usual sitting postures were identified between subgroups of chronic low back pain (patients with an active extension pattern or a flexion pattern) and healthy controls (Dankaerts et al., 2006). In an older population, increase in thoracic kyphosis was associated with increased incidence of intrascapular pain, next to increased body sway, gait unsteadiness and higher risk of falls (Fon et al., 1980; Griegel-Morris et al., 1992; Sinaki et al., 2005).

Previously, four standing postures have been described based on sagittal X-rays: a 'neutral' (or 'optimal') posture, a 'hyperlordotic' posture (lumbar lordosis and thoracic kyphosis), a 'flat back' (flattened lumbar and thoracic curves) and a 'sway back' posture (backward displacement of the thoracic relative to the pelvis) (Kendall et al., 1993). Subdivision into these postural types was based both on pelvic orientation and the rate of kypholordosis of the thoracolumbar spine. However, correlations between the different spinal regions for the different subtypes remained unclear. More recently, this subdivision was also demonstrated using digital sagittal photographs in combination with external markers on anatomical bony points (Smith et al., 2008). In this study, neutral spinal postures were less associated with LBP.

The pelvic orientation plays an important role for sagittal spinal curvature in standing: pelvic anteversion may be associated with more lumbar lordosis, pelvic retroversion may be related to less lumbar lordosis and possibly a more forward position of C7 relative to the sacrum (Roussouly and Pinheiro-Franco, 2011). For both standing (Dunk et al., 2005; Kuo et al., 2009; O'Sullivan et al., 2006b) and sitting (Black et al., 1996; Kuo et al., 2009; Sprigle et al., 2002), a method of using external markers in combination with digital photographs to analyze sagittal posture was shown to be reliable and valid in postural evaluation. Using this research methodology, statistically significant correlations between the lumbopelvic and the cervical region in end-range sitting postures (i.e. erect and slouched sitting) were demonstrated: a more lumbar extended position was correlated with a more flexed cervical spine (mid and lower); in contrast, more lumbar flexion correlated with more cervical extension (Black et al., 1996). However, variation in movement between upper and lower cervical spine among subjects was demonstrated and the correlations between the pelvis and the neck were statistically significant, but very small (Black et al., 1996). Furthermore, the role of the correlations between the lumbar/thoracic spine and the pelvis or the neck were not evaluated in this study and remained unclear. More recently, it was demonstrated that increased flexion of the thoracic spine correlated with more head extension in sitting as well as in standing (O'Sullivan et al., 2002; Straker et al., 2009). Kuo et al. (2009) were the first to investigate postural correlations of all spinal regions in both usual standing and sitting. However, only correlations between adjacent spinal regions were reported. As a consequence, the magnitude of the spinal interaction between the lumbopelvic region (pelvis, lumbar spine) and the cervical spine remains unknown.

While postural rehabilitation often plays an important role in contemporary clinical management of spinal problems, there is still a paucity of studies investigating spinal correlations during commonly adopted postures such as usual standing and sitting. As a result, the aim of the current study was to investigate the postural correlations between two spinal angles (pelvic tilt and the trunk angle) and all other spinal regions (lumbar, thoracic, cervical and head) in usual standing and usual sitting.

Methods

Subjects

A total of 99 subjects (25 men and 74 women) without spinal problems were recruited to voluntarily participate in this study. Participants were first year physiotherapy students and confirmed to have no recent spinal (cervical, thoracic or lumbar) pain. All subjects gave their written informed consent. Test procedures were approved by the Medical Research Ethics Committee of KU Leuven with respect to the declaration of Helsinki (Ethical Principles for Medical Research Involving Human Subjects) (Riis, 2003). Table 1 shows the characteristics of the subjects.

Instrumentation and methods

Prior to data collection, photo-reflective markers were attached on the right side of nine bony points of each subject: just lateral of the eye, just anterior of the ear, spinous process of the cervical vertebra C7, spinous process of the thoracic vertebra T12, spinous process of the lumbar vertebra L3, spinous process of the sacrum S2, anterior superior iliac spine (ASIS), greater trochanter (midpoint).

After the placement of the markers digital photographs were taken from the usual standing and usual sitting posture of the subject. For the usual standing position, subjects were asked to stand as usual, with their feet 10 cm apart, with their gaze horizontally and with both arms loosely along their body. To optimize visibility of the markers on the pelvis and trochanter the right elbow was passively flexed by the investigator without moving other regions. For usual sitting, a height adjustable stool was used. Subjects were positioned with a 90° angle between femur and tibia. A standard goniometer was used to ensure a 90° angle at the knee joint. The rotational axis of the goniometer was placed at the center of the lateral femoral condyle, one arm was set parallel to the long axis of the

Table 1 Characteristics of the subjects.

Gender (M/F)	25/74
Age y	19.6(1.6)
Weight kg	64.3(8.9)
Height cm	171.4(7.9)
BMI kg/m^2	21.89(2.3)

Entries are mean(SD), BMI = body mass index.