Concurrent Validity of the Occiput-wall Distance as Compared to a Standard Cobb's Method to Measure Kyphosis in Elderly

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ABSTRACT

Kyphosis can lead to many adverse health and other health-related consequences that further affect levels of functioning of elderly. Therefore, a standard practical method is important to early detect and monitor the abnormality both in clinics and communities. The occiput-wall distance (OWD) is widely used to quantify severity of kyphosis in epidemiological studies. However, there is no evidence to confirm the validity of OWD as compared to a standard radiographic Cobb's method. Forty-eight community-dwelling elderly, aged at least 60 years with different degrees of kyphosis, were assessed for severity of kyphosis using OWD and the radiographic Cobb's method. The Pearson correlation coefficient was used to quantify the concurrent validity of OWD as compared to a standard method. The findings demonstrated that the OWD had excellent correlation with radiographic Cobb angles ($r = 0.93$, $p<0.001$). Thus, the findings confirmed concurrent validity of OWD as a simple tool to measure severity of kyphosis in various settings. Furthermore, the findings may promote effectiveness of health care services and standard referral systems among health care professionals.

Keywords Kyphosis, X-ray, Screening tool

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Introduction

Kyphosis is commonly characterized by a backward deviation of the thoracic spine exceeding 40 degrees (Kado *et al*., 1999; Kado *et al*., 2007). The condition tends to increase with age and the angle of kyphosis is the most pronounced in oldest age groups (Fon *et al*., 1980; Korovessis *et al*., 1998; Boyle *et al*., 2002). Kyphosis can lead to many adverse health and other health-related consequences such as impaired pulmonary functions, diminished physical functions, increased a risk of fall and spinal fracture. These consequences superimpose substantial effects to levels of functioning and mortality rate in elderly (Di Bari *et al*., 2004; Kado *et al*., 2007; Katzman *et al*., 2010). Apart from treatment, therefore, it is important to explore for a practical method to to early detect and monitor the abnormality, indicate effectiveness of the treatments, and minimize harmful consequences of kyphosis.

In epidemiological studies, the occiput-wall distance (OWD) is widely used to measure kyphosis (Balzini *et al*., 2003). The method can be easily executed using the perpendicular distance between the occiput and the wall in an upright standing position (Antonelli-Incalzi *et al*., 2007; Wongsa *et al*., 2012). Nonetheless, to best of the researchers' knowledge, there is no evidence to confirm the validity of OWD as compared to a standard Cobb's method.

Objectives of the study

To evaluate concurrent validity of OWD as compared to a standard radiographic Cobb' s method to quantify severity of kyphosis in elderly.

Methods

Subjects

Subjects were community-dwelling elderly with different degrees of kyphosis as determined using OWD (OWD > 0cm), aged at least 60 years and with a body mass index between 18.5-29.9 kg/m^2 (Wongsa *et al*., 2012). Exclusion criteria were any signs and symptoms that might confound data interpretation for spinal angles such as abnormal fat mass in the upper thoracic area, wing scapular, pain or inflammation in the muscles or joints, and other spinal or limb deformities i.e. scoliosis, amputation and leg length discrepancy. An appropriate number of sample sizes was calculated which the correlation coefficient (r) was set at 0.45 (Lachin, 2004), the significant level was set at 0.05 and power level was 0.80. Thus the study needed at least 48 subjects. Protocols of the study were approved by the Khon Kaen University Ethics Committee for Human Research, Khon Kaen, Thailand (HE581446). The subjects provided a written informed consent approved by the local ethics committee prior to taking part in the study.

Experimental protocol

The eligible subjects were cross-sectionally interviewed and assessed for their demographics; including age, gender, weight and height and OWD. Then, on the second day or within 7 days later, they were at a radiodiagnosis department, Ratchaphruek hospital for a lateral plain radiograph. Details of kyphosis measurements are as follows;

Kyphosis measure using occiput-wall distance

Subjects stood upright as tall as possible with both heels, sacrum and back against the wall. Their head was in a neutral position as determined using the lower orbital margin and upper margin of the acoustic meatus on a

horizontal plane (Antonelli-Incalzi *et al.*, 2007; Wongsa *et al.*, 2012). The perpendicular distance from the bony prominence of occiput to the wall was measured using 2 rulers, in which the first ruler was placed on the occiput and another ruler measured the perpendicular distance from the first ruler to the wall (Figure 1) (Antonelli-Incalzi *et al.*, 2007; Wongsa and Amatachaya, 2014). The measurement was executed by 3 physiotherapists who had good experience in OWD (ICC = 0.98 - 0.99) for 3 trials/subjects with a period of rest as needed between the trials. Then average distance over the 3 trials was recorded.

Figure 1 The kyphosis measure using the occiput-wall distance (OWD)

Kyphosis measure using the radiographic Cobb's method

A radiographic Cobb's method is accounted as the most reliable and accurate method (ICC = 0.96 - 0.99); thus it is commonly used as a gold standard to validate a new tool for kyphosis measurement (Brigg *et al.*, 2007; Kado *et al.*, 2007). Subjects were filmed for lateral spinal radiography over the area of thoracic spine (the 1st thoracic vertebral [T1] to the 12th thoracic vertebral [T12]) in an upright standing position. The Cobb angle was subsequently analyzed by 3 experienced physiotherapists who had excellent reliability (ICC = 0.99) using a SurgimapSpine program by drawing a straight line passed the upper border of the 4th thoracic vertebra (T4), and another line passed the inferior border of T12. Then the other 2 lines were drawn perpendicularly with the first 2 lines, and the angle of their intersection was the Cobb angle which was automatically computed by the SurgimapSpine program (version 1.2, Nemaris Inc, 306 East 15th St Suite 1R NY, New York 10003) (Suwannarat *et al.*, 2017; Wu *et al.*, 2014).

Data analysis

Statistical analyses were performed using the SPSS program (SPSS Statistics version 17. 0, IBM Corporation, 1 New Orchard Road Armonk, NY, USA, serial number: 5068054). The descriptive statistics were used to explain demographics and findings the study. Pearson's product moment correlation was used to quantify levels of correlation between Cobb angle and OWD. Levels of significant differences were set at $p<0.05$.

Results

Forty-eight subjects, with an average age of 77.02±5.39 years (range: 65-88 years) and an average body mass index of 23.21±3.65 kg/m^2, participated in the study. Their OWD could be completed within 2-3 minutes with the average OWD of 5.90±3.41cm and average Cobb angle of 36.77±11.31 degrees (Table 1). Data from OWD demonstrated excellent correlation with the Cobb angle (r = 0.93, p<0.001; Figure 2).

Table 1 Demographics of subjects and findings of the study (mean ± SD, n=48)

Variable	Findings
Gender: female/male (n[%])	34(70.83)/14(29.17)
Body weight (kg)	53.72±11.77
Height (m)	1.52±0.09
Cobb angle (degrees)	36.77±11.31
Occiput-wall distance (cm)	5.90±3.41

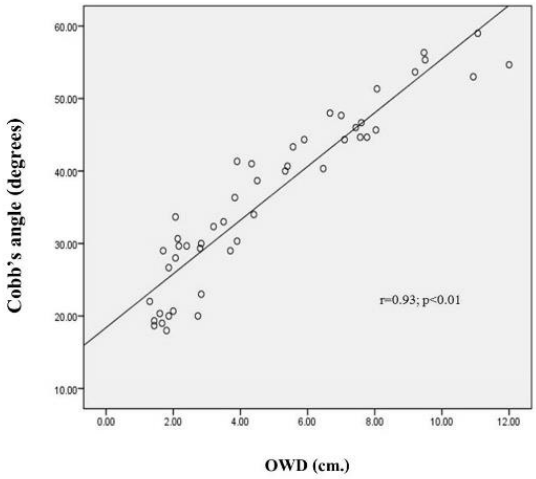

Figure 2 Relationship between occiput-wall distance (OWD) and Cobb angle (r = 0.93, p<0.001)

Discussion

This study assessed the concurrent validity of the OWD using data from the radiographic Cobb's method. The findings indicated that outcomes of the measurement demonstrated excellent correlation with spinal angles as measured using the radiographic Cobb's method (r=0.93; p<0.01).

The strong association between data from OWD and the radiographic Cobb angle can be explained by effects of postural change and kinematic linkage of the spinal curvature. The changes of spinal curvature due to

various causes such as muscle weakness, obesity, osteoporosis, or abnormal muscle length that affect cervical, lumbar and sacral spinal areas can influence thoracic curvature. On the contrary, the increase of thoracic kyphosis can inversely change alignment of other spinal areas, including cervical spinal curve that subsequently increase perpendicular distance from occiput to the wall when standing against the wall (Kado, 2009). Therefore, after controlled for possible confounding factors such as abnormal fat mass or head position, the alteration of OWD showed excellent correlation with spinal angles as measured using radiographic Cobb's method.

The current treatments and assessments emphasize on the improvement of community health care services and health for all. The findings suggested the use of OWD as a standard simple tool, that could executed within 2-3 minutes, to screen and monitor kyphosis in clinical and community settings. Using data from OWD, the severity of kyphosis can be classified into 3 groups, including mild (5 cm), moderate (5.1-8 cm), and severe (>8 cm) (Balzini *et al.*, 2003). Thus the findings may help to promote standardized referral system for kyphosis among health care providers. This strategy is crucial to early detect and follow-up the abnormality, promote effectiveness of the treatments, and minimize the harmful consequences of kyphosis that may occur to the elderly (Kado *et al.*, 2007; Kado, 2009). Apart from elderly, the OWD may be used to screen severity of kyphosis in other age groups who are at risk of kyphosis due to the change of life style in a current era i.e., reduce physical activities and spend a long time using social media.

Nonetheless, there are some limitations of this study. The study included only elderly subjects because kyphosis commonly occurs in these individuals, probably between 20-40% among both men and women (Kado *et al.*, 2007). Thus the data may not clearly indicate the use of OWD in other age groups who have more flexible spinal curvature, such as children or adulthoods. Moreover, the assessor in this study was a health care professional who was well-trained for the anatomical landmark and palpation skill. Thus the findings may not imply the use of OWD in other community health care providers such as village health volunteers. In addition, this study applied an occiput as a landmark of measurement because it is commonly used in previous studies (Balzini *et al.*, 2003; Davis and Gladman, 2007; Antonelli-Incalzi *et al.*, 2007; Simonski *et al.*, 2011). However, some recent studies used C7 as a landmark because they believed that it may truly reflect compensatory distance due to thoracic kyphosis and minimize chance of error when a subject moving their head. Therefore a further study should include subjects with various age groups and novice assessors, and apply C7 as a landmark to thoroughly confirm the use of OWD for kyphosis measurements in various clinical and research settings.

Conclusions

Findings of this study confirmed concurrent validity of OWD as a simple assessment for kyphosis measurement in elderly. Thereby the findings may promote the standardization of the method to early detect and monitor the severity of kyphosis among many clinical settings, in particular a current era that the number of elderly is dramatically increased.

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