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RESEARCH PAPER

Reliability of novice physiotherapists for measuring Cobb angle using a digital method

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KEYWORDS
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Abstract *Background:* The Cobb's method is the most accurate and reliable method for kyphosis measurement. Conventionally, a sagittal Cobb angle was commonly derived from a lateral plain film. With computer technology, a digital method is widely used in common clinical settings, but the existing reliability data involved only experienced raters.
Objectives: To assess the interrater and intrarater reliability of a digital Cobb's method using novice physiotherapists.
Methods: Fifteen participants, with an occiput wall distance of more than 0 cm, were interviewed and assessed for their demographics. Then they were filmed for lateral spinal radiography over the area of thoracic spine in a standing position, and the Cobb angle was analyzed by four raters, including an expert physician and three novice physiotherapists, using a SurgimapSpine programme.
Results: The average Cobb angles among the four raters showed no significant difference ($p = 0.984$). Outcomes of their measurements had excellent intrarater and interrater reliability [intraclass correlation coefficient ($ICC_{3,3}$) = 0.995–0.997] with a small range of standard errors of the measurement (<1°).
Conclusion: A digital Cobb's method had excellent reliability when used by a novice health professional rater. The findings confirm the ease of using this method to detect and monitor kyphosis in general hospitals, clinics, or research facilities.

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Introduction

The Cobb's method is one of the most common techniques to measure spinal curvature using radiograph. It was first described in 1948 by an American orthopedic surgeon, Dr John Robert Cobb, who outlined how to measure the angle of spinal curvature. Hence, the term "Cobb angle" came about bearing his name [1]. Originally, the Cobb angle has been used to measure coronal spinal deformity. Later, it was adapted to measure sagittal spinal angle, as the so-called kyphosis angle [2]. The method is accounted as the most accurate and reliable method [intraclass correlation coefficient (ICC) = 0.96–0.99]; thus, it is commonly used as a gold standard to validate a new kyphosis measure [3,4].

Previously, a sagittal Cobb angle was derived from a lateral plain film by drawing a straight line that passed the upper border of the fourth thoracic vertebra (T4), and another line that passed the inferior border of the 12th thoracic vertebra (T12). Then two other lines were drawn perpendicularly with the first two lines, and the angle of their intersection or the Cobb angle was measured using a protractor [4,5]. The intrarater and interrater reliability of this conventional Cobb's method has been reported among various raters including experienced physicians (ICC = 0.94), fellowships (ICC = 0.79–0.99), residents (ICC = 0.96–0.99), and rheumatologists (ICC = 0.91–0.95) [6–8]. However, with computer technology, a digital method offers a superior option for Cobb angle interpretation as compared to the conventional method. It allows data interpretation using a desktop computer, a laptop, or a smartphone, and reduces the cost for developing a plain film, storage areas for hard copies, and time required for data interpretation. In addition, digital software such as AutoCAD and SurgimapSpine offer a better view of the vertebra morphology through the adjustment of contrast and enlargement, which eases the measurement of distances and angles [9,10]. Consequently, various digital techniques are increasingly used in routine clinical assessments.

Currently, there is only a limited amount of reliability data of the digital Cobb's method, and all of them involve an experienced physician rater (ICC = 0.81–0.96) [9,11–13]. Apart from physicians, a physiotherapist is another important professional for kyphosis management to normalise or minimise the progression of kyphosis angle [5]. Briggs et al [14] have reported the reliability data of experienced physiotherapists who commonly evaluate Cobb's method. However, the reliability data of novice or inexperienced physiotherapists would confirm the ease of using a digital Cobb's method to detect and monitor kyphosis in general hospitals, clinics, or research institutions. Therefore, the current study aimed to evaluate the interrater and intrarater reliability of a digital Cobb's method that was measured by novice physiotherapist raters using computer-ancillary technique sagittal plane radiographs.

Methods

Participants

This study was cross-sectionally conducted from January to June 2016. The eligible participants were at least 18 years old with an occiput wall distance (OWD) of >0 cm [15–17]. Exclusion criteria were any signs and symptoms of lower limb neurological compromises such as pain or inflammation in the muscles or joints, and other spinal or limb deformities that might confound data interpretation for spinal angles, i.e., scoliosis, amputation, and leg length discrepancy. The protocols of the study were approved by the Khon Kaen University Ethics Committee for Human Research, Khon Kaen, Thailand (HE581446).

Research protocol

Walter et al [18] have suggested the method of sample size estimation for reliability studies using ICCs. The study set a true p_0 at 0.4 (minimally acceptable level), an alternative p_1 of 0.75, a 5% significance level, and a power of 80% ($\beta = 0.20$). Thus, the study required at least 14 participants. The eligible participants were interviewed and assessed for their demographic characteristics, including age, sex, weight and height. Then, they were filmed for lateral spinal radiography over the area of the thoracic spine [the first thoracic vertebral (T1) to the 12th thoracic vertebral (T12)] in an upright standing position. The Cobb angle was subsequently analyzed by four raters using the SurgimapSpine software (version 1.2, Nemaris Inc, 306 East 15th St Suite 1R NY, New York 10003). The characteristics of the raters and details of the Cobb angle interpretation are presented in the following subsections.

Characteristics of raters and training protocols for digital Cobb measurement

This study involved four raters, which comprised a physician who had extensive experience in digital Cobb's method (an expert) and three physiotherapists who did not have any experience in a digital Cobb measurement. At the beginning of the study, the three novice physiotherapist raters were trained by the expert. The training protocols consisted of didactic and demonstration in the areas relating to digital measure, including the basic spinal anatomy of the spine using data from an X-ray illustration, and instructions on (1) how to use the SurgimapSpine software, (2) how to find a landmark, and (3) how to read the angle from the programme. Then the three novice raters practiced using these methods until the expert was satisfied with their performance. In aggregate, the training time took approximately 45 minutes.

Methods of Cobb angle measurement using a digital programme

To achieve a Cobb angle, a digital X-ray file was uploaded to the SurgimapSpine programme. Then, a straight line was drawn that passed the upper border of the T4 vertebra, and another line that passed the inferior border of the T12 vertebra. Then, two other lines were drawn perpendicularly with the first two lines, and the intersection of these two lines produced the Cobb angle [3,4]. Each rater carried out the measurements independently (three separate trials per rater), and the finding of each trial was blinded for a subsequent trial and for another rater.

Data analysis

Statistical analyses were performed using SPSS (SPSS Statistics version 17.0; IBM Corporation, Armonk, NY, USA; serial number: 5068054). The descriptive statistics [mean, standard deviations (SD) and 95% confidence intervals] were used to explain the demographics and findings of the study. One-way analysis of variance was used to analyze the differences among the four raters. The reliability of the measurements was reported using the ICC(3,3) [the 3 raters were the only raters of interest, not randomly selected, and the reliability was calculated using average data over 3 measurement times], standard error of measurement ($SEM = (SD\sqrt{1-ICC})$ and minimal detectable change ($MDC = 1.96^{*}\sqrt{2} * SEM$ [19,20]. The ICC values are rated poor (less than 0.40), fair (0.40—0.59), good (0.60—0.74), or excellent (0.75—1.00) [19]. The level of significance was set at $p < 0.05$.

Results

Fifteen participants (4 males and 11 females), with an average age of 50.84 ± 23.15 years (range, 20—78 years) and an average body mass index of 22.73 ± 3.06 kg/m^2, participated in the study. Each rater spent time to interpret a Cobb angle in 10—20 minutes, depending on the quality of the file. The average Cobb angle of the participants was $28.64 \pm 9.66^{\circ}$ (range, 9—52°), and the angle showed no significant differences among the four raters ($p = 0.98$). Table 1 shows the Cobb angle, reliability, SEM, and MDC data of all raters, in which outcomes of their digital Cobb measurements had excellent intrarater and interrater reliability with an SEM range of 0.53—0.89° and an MDC range of 1.47—2.47°.

Discussion

Cobb's method has been regarded as a valid and reliable method for measuring kyphosis [3,4]. However, most of the existing reliability data involved a conventional Cobb's method and experienced raters (including physicians, fellowships, residents, and rheumatologists) [6—8]. With computer technology, a digital Cobb's method offers a superior option for Cobb angle interpretation as compared to a conventional plain film. Therefore, it is of interest to evaluate the ease of using this method from the viewpoint of a novice rater. Findings of the current study indicate that the digital Cobb measurement had excellent intrarater and interrater reliability with a small range of SEM and MDC (Table 1).

A conventional Cobb's method showed a wide range of reliability data (ICC = 0.79—0.99) [6—8], which may suggest problems in data interpretation while using a plain film, including the difficulty of identifying a vertebral endplate, landmark of measurement, as well as defective angle measurement as a result of using different protractors, pencil, and ruler [10,21]. On the contrary, computer-based kyphosis measurement can be executed using several software such as AutoCAD and SurgimapSpine, depending on availability, accessibility, and familiarisation of the users [9,10]. These programmes allow superior options for image enlargements and adjustment for brightness and contrast that enable better vision and identification for key anatomical landmarks or other important parts of the spine. After drawing the lines through the vertebral endplates, the software measures the angle automatically, which further reduces the sources of error [9,10,21]. Thus, the current findings indicated that, after proper training, novice health professional raters had excellent reliability for digital Cobb measurement (ICC = 0.995—0.997) with a small range of SEM and MDC (Table 1). The SEM infers absolute reliability or the possible margin of measurement errors in an original unit, and the MDC indicates the minimal change that falls outside the measurement errors in the results of the measurement used [20,22]. The findings were consistent with previous reports that involved experienced physician and physiotherapist raters who commonly used a digital Cobb's method (ICC = 0.81—0.96) [9,11—13]. Thus, the findings confirm the ease of using a digital Cobb's method for kyphosis measurement.

Nowadays, kyphosis can be found in all age groups (30% in teenagers [23], 35% in adults [24], and 40% in the elderly [4,5]). Changes in current lifestyles are prompting people to reduce their levels of physical activity and spend a considerable amount of their time sitting with an extreme flexion posture. Such changes may hasten the development of kyphosis in early age groups. Findings of the present study suggest the possibility of using a digital Cobb's method, after proper training, to detect and monitor kyphosis in general hospitals, clinics, or research institutions.

Table 1 Reliability data of a digital Cobb measurement.

Variable	Rater 1 (expert)	Rater 2	Rater 3	Rater 4	*p*
Cobb's angle[a]	28.64 ± 9.66 (23.29—34.00)	28.60 ± 9.81 (23.17—34.03)	29.58 ± 9.10 (24.54—34.62)	29.62 ± 9.88 (24.15—35.09)	0.984
Intrarater reliability[b]	0.997 (0.997—0.999)	0.996 (0.996—0.999)	0.995 (0.989—0.998)	0.995 (0.987—0.998)	<0.001
SEM (deg)	0.53	0.62	0.64	0.69	
MDC (deg)	1.47	1.72	1.77	1.91	
Interrater reliability[b]	0.991 (0.981—0.997)				<0.001
SEM (deg)	0.89				
MDC (deg)	2.47				

MDC = minimal detectable change; SEM = standard error of measurement.

[a] Data are presented using mean ± standard deviation with 95% confidence interval, and compared using the one-way analysis of variance (ANOVA).

[b] Data are presented as the intraclass correlation coefficients [ICCs (3,3)] with 95% confidence interval.

Nonetheless, there are several limitations in this study. First, participants were conveniently recruited in a wide age range with the use of OWD $>$ 0 cm as a screening criterion [15—17]. However, the OWD $>$ 0 cm condition may be attributed to other factors, apart from kyphosis (i.e., wing scapular and chin out conditions), and this resulted in the recruitment of participants who had a wide range of spinal angles (between 9° and 52°). A further study should use other criteria to clearly reflect the kyphotic spine. van der Jagt-Willems et al [25] suggest that using OWD $>$ 5 cm may better represent the change of spinal angle in a sagittal plane than OWD $>$ 0 cm.

Conclusion

The findings confirm the excellent reliability of a digital Cobb angle when assessed by novice physiotherapist raters . Thus, after an appropriate training protocol, the findings confirmed the ease of using a digital Cobb's method to detect and monitor the abnormality of sagittal spinal curvature in general hospitals, clinics, or research facilities.

Conflicts of interest

None.

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Authors' contributions

Conception and design of study: P. Suwannarat, S. Amatachaya.

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