Reliability of “MB-Ruler Software” to Measure Craniovertebral Angle Using the Photographic Method

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Abstract

Background The craniovertebral angle (CV angle) measurement is a convenient and easy clinical method for the cervical posture assessment. “Markus Bader (MB) ruler software” assists to measure angles and distances on the computer screen. The MB-ruler protractor is almost transparent; hence, it can be easily used on the computer screen. Many studies in physiotherapy have used this software for postural assessment with the photographic method, but the reliability of this software is not available to our knowledge in the Indian population.

Aim The aim of this study was to find inter-rater and intra-rater reliabilities of “MB-Ruler software”, by using the photographic method to measure the CV angle for the cervical postural assessment.

Study Design This is an observational study in healthy young population.

Subjects and Method Total 30 young student volunteers with no clinical symptoms were enrolled for this study. A single standard lateral view image in a sitting position was used for CV angle measurement with “MB ruler software.” Three readings of the CV angle were taken by three different observers (A, B, and C) separately at intervals of time. The CV angle measured by three observers was compared.

Results Cronbach’s α coefficient value for intra-rater (ICC 0.999) (intra-class correlation coefficient) as well as inter-rater (ICC 0.892) reliability for measuring CV angle was very high.

Conclusion MB ruler demonstrates high intra-rater and inter-rater reliabilities and can be used for the photographic evaluation of posture by assessing the CV angle.

Keywords
- MB ruler software
- intra-rater reliability
- inter-rater reliability
- photographic postural assessment

Introduction

“Craniovertebral angle” (CV angle) measurement is a convenient and easy clinical method for the cervical posture assessment.[1] The angle formed by the intersection of the horizontal line passing through C_7 and a line extending from the tragus of the ear to C_7 is known as the “CV angle.”[2] This method can be used reliably to assess natural head-neck posture in the sagittal plane (intra-class correlation coefficient [ICC] = 0.98).[1]

The spinal postural assessment is often necessary in physiotherapy practice and research. The objective

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assessment of the spinal posture can be done by methods like X-ray, 3D motion analysis, raster stereography, and photographic postural analysis. The radiographic assessment is considered the "gold standard" in the literature as it provides clear images of reference points, but it is not preferred in studies because of the exposure to radiation. Three-dimension motion analysis is an accurate and reliable method, but it is not used generally due to the requirement of expensive equipment and laboratory conditions. The video raster stereography analysis method is reliable and enables the automatic assessment of spinal motion by multidirectional high-resolution video recording, but it lacks validity. Many manual methods are available for the postural assessment like goniometer, flexible ruler, and observational postural analysis by using the line of gravity. Although manual methods are simple and convenient, they are subjective. Photographic posture analysis is one of the frequently used, basic, and observational assessment methods. This approach uses anatomical reference points for postural angle measurement. The literature supports the clinical use of the photographic postural assessment because it is a meticulous and objective approach.[3]

The photographic postural evaluation is a convenient and reliable method, with inter-rater ICC > 0.972 and intra-rater ICC > 0.774.[3] The CV angle can be used reliably to assess cervical posture in the sagittal plane (ICC = 0.98).[1] Hence, this study was conducted to investigate the inter-rater and intra-rater reliabilities of MB ruler software using the photographic method to measure the CV angle.

MB ruler is a measuring toolbox, which can be used to measure and track elements on the computer screen. This software is cost-effective, convenient to use, and easily available online. It features a triangular ruler (on-screen goniometer) (►**Fig. 1**) that helps to detect angles on the image displayed on the computer screen.[4]

MB-Ruler has three instruments for measurements:

- A triangular ruler to measure distance and angles.
- A horizontal and vertical ruler with help lines.
- A screen grid that divides the site in equal rectangles.

All three instruments are often shown and hidden by an easy click.[4]

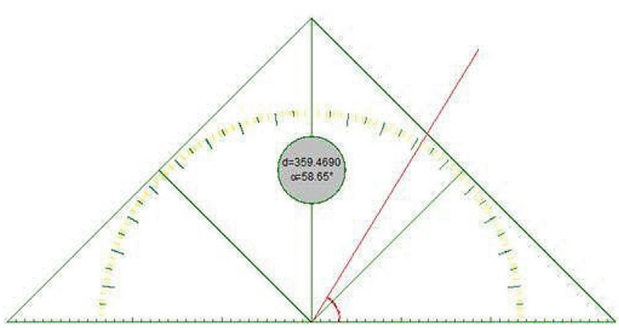


Fig. 1 MB ruler software.

Method

In this study, "MB-Ruler 5.0 software" (Markus Bader-Software Solutions, triangular screen ruler) was used. Permission was obtained from the authority for the utilization of the software.

Ethical Approval and Informed Consent

The ethical approval was obtained from the institutional ethical committee. The written informed consent documents were signed by the subject before entering the study.

Subjects

A total of 30 physiotherapy students of 20 to 25 years of age, who were asymptomatic, healthy, and willing to participate were enrolled in the study.

Methodology to Mark the C_7 Spinous Process and Tragus of Ear

The spinous processes of C_6 and C_7 vertebrae are evident. The subject's neck was passively flexed and extended to differentiate between C_6 and C_7 vertebrae. The C_6 spinous process is mobile, whereas the C_7 spinous process remains stable with the movement.[5] This palpation technique was used to identify the C_7 spinous process. A body surface sticker was used to mark the C_7 spinous process and tragus of the ear.

Methodology to Take Standard Image

A collarless dress was worn by the subject for the photographic session.[1] All subjects were informed to sit comfortably on a high back chair with both feet flat on the ground, hips and knees positioned at 90 degrees, and buttocks positioned against the back of the chair. They were instructed to sit as regularly they sit and place their both hands on the lap.[2] Subject's neck was positioned such that their gaze was fixed on the reference point in the eye-line on the wall facing the subject.[1] The COOLPIX S6300 camera with 50% zooming power and flash on was used to take images. The camera was supported on a tripod. The height (distance between the lens of the camera and floor) was 110 cm, and distance (distance between the lens of the camera and subject's tragus of the ear) was 150 cm. The height of the camera from flooring, distance of the camera from the subject, and focus alignment orientation of the camera were kept constant and assured for each shoot.[1] The camera was placed such that all anatomical markers were visible in the single image.[6] One standard lateral view image was taken in the sitting position for the measurement of the CV angle.[2] As per the study done by Niekerk et al, photographs provide accurate and reliable indicators of the position of the underlying spine.[6]

CV Angle Measurement

The photographs were transferred to the computer via USB data transfer cable and used for the CV angle assessment.[2,6] The CV angle was evaluated by using "MB-Ruler 5.0 Software" (►**Fig. 2**).

Inter-Rater Reliability

The same single image was individually evaluated by three different observers A, B, and C as shown in ►**Table 1**. First day

Fig. 2 Measurement of the CV angle by MB ruler software.

observer A evaluated images for reading A1. Next day observer B evaluated the same images for reading B1, followed by C1 readings by observer C on the next day, for the evaluation of inter-rater reliability. In a similar way, A2, B2, and C2 and A3, B3, and C3 readings were taken on the consecutive days.

Intra-Rater Reliability

All three observers repeated the evaluation on the fourth day for test–retest analysis. First day observer A took A1 readings, on the fourth day the same observer took A2 reading, and on the seventh day A3 reading. B1, B2, and B3 readings were taken by observer B on day two, five, and eight. In similar ways, reading C1, C2, and C3 were taken by observer C on day three, six, and nine, respectively (►**Table 1**).[1]

Results

Data were analyzed using SPSS 25 (►**Table 2**). The statistical significance was set at $p < 0.05$. The outcome measure used is the CV angle.

The demographic details of the subjects are mentioned in ►**Tables 3** and **4**.

In this study, 30 volunteer students (11 boys and 19 girls) in the age range of 20 to 25 years were involved. The CV angle was evaluated by MB ruler software by three different observers. It was found that the CV angles measured by MB ruler software in the present study were reliable and repeatable (**Graph 1**, **2**, and **3**).

Cronbach's α coefficient value of intra-rater (0.999) and inter-rater (0.892) reliabilities is observed to be high (►**Table 5**); thus, "MB ruler software" is reliable for assessing the CV angle.

Discussion

In the present study, the inter-rater and intra-rater reliabilities of the MB ruler software using the photographic method for the evaluation of the CV angle were investigated with 30 samples and it has been found to be reliable. For the evaluation of the CV angle, the inter-rater (ICC > 0.999) and intra-rater (ICC > 0.892) reliabilities of the MB ruler software were

Table 1 Evaluation of the CV angle by observer A, B, and C

Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
Reading	A1	B1	C1	A2	B2	C2	A3	B3	C3

Table 2 Statistical analysis

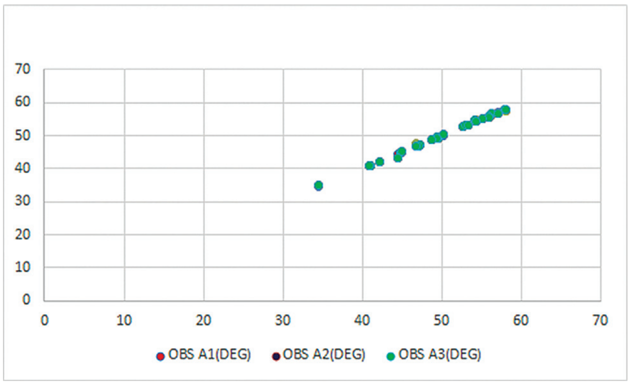
	Intra-class correlation	95% Confidence interval	
Observer		Lower bound	Upper bound
Observers A vs. B	0.92	0.83	0.96
Observers A vs. C	1.00	1.00	1.00
Observers B vs. C	0.92	0.83	0.96
Observers A1 vs. A2	1.00	1.00	1.00
Observers A1 vs. A3	1.00	1.00	1.00
Observers A2 vs. A3	1.00	1.00	1.00
Observers B1 vs. B2	0.92	0.83	0.96
Observers B1 vs. B3	0.92	0.82	0.96
Observers B2 vs. B3	1.00	1.00	1.00
Observers C1 vs. C2	1.00	1.00	1.00
Observers C2 vs. C3	1.00	1.00	1.00
Observers C2 vs. C3	1.00	1.00	1.00

Table 3 Age distribution (years)

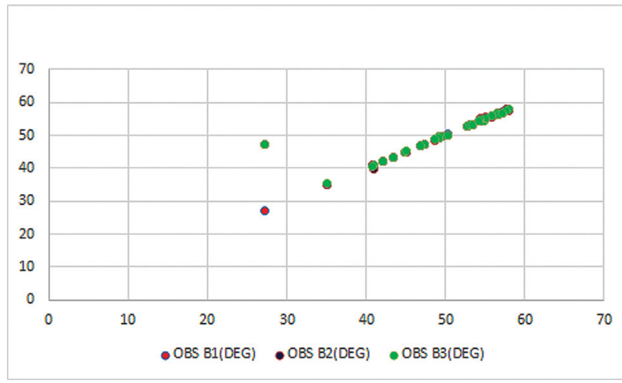
Mean	22.90
SD	1.66
Min	20
Max	25

Table 4 Gender distribution (numbers)

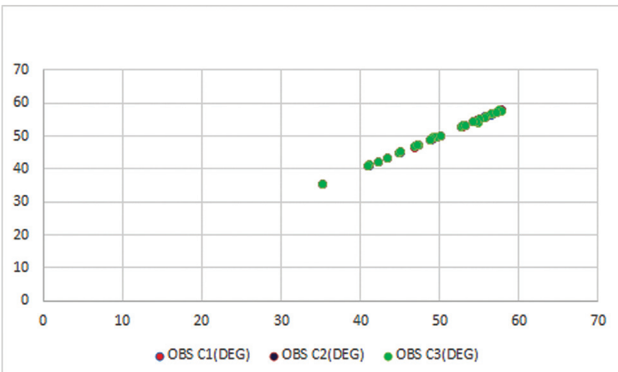
	Number	Percent
Female	19	63.3
Male	11	36.7



Graph 1 Intra-rater reliability observer A.



Graph 2 Intra-rater reliability observer B.



Graph 3 Intra-rater reliability observer C.

Table 5 Cronbach’s α coefficient

Cronbach’s α coefficient value of intra-rater reliability	0.999
Cronbach’s α coefficient value of inter-rater reliability	0.892

Table 6 ICC values with interpretation

ICC value	Interpretation
<0.70	Non-acceptable
$0.71 < \text{ICC} < 0.79$	Acceptable
$0.80 < \text{ICC} < 0.89$	Very good
$\text{ICC} > 0.90$	Excellent

Abbreviation: ICC, intra-class correlation coefficient.

Table 7 Reliability studies of different spinal angle measurement methods

Author	Publication year	Methodology	Subjects gender and age	Sample size	ICC
Mcevoy et al.[9]	2005	Photographic posture assessment	boys and girls 5–12 years	38	$\geq$0.93
Perry et al.[10]	2009	Photographic posture assessment	male and female aged 13–17 years	22	Interrater 0.40–0.75 Interrater 0.75–0.90
Pusic et al.[11]	2010	Manual & automatic measurement in photographic posture analysis	males between 10–13 years	273	Automatic 0.81–0.92 manual 0.80–0.91

Abbreviation: ICC, intra-class correlation coefficient.

observed to be in the range of very good to excellent. In this study, inter-rater and intra-rater ICC classifications were made based on the study done by Ferreira et al as mentioned in ►**Table 6.**[7]

In the literature, there are handful of reliability studies on the spinal angle measurements, which utilized various methods in different age groups, as mentioned in ►**Table 7**.

The existing postural assessment methods are subjective. The objective and reliable approaches are expensive, require special training, or equipment. On the contrary, the photographic postural assessment is an economical and simple method of posture evaluation. MB ruler software that can be used for photographic postural analysis is low cost, advantageous in terms of easy availability and application, and often used in research studies; hence, finding its reliability was important.[3]

It was found that the CV angles evaluated by MB ruler software in this study were reliable and repeatable. As this study has proven the reliability of the MB ruler software, it can be used for the clinical and research work to evaluate postural angles.

The essential component of the current study was that an easily accessible MB ruler software was used for the assessment of the angles. The limitation of the study was the small sample size; future study can be done on a large group.

Conclusion

MB ruler software has good intra-rater (ICC = 0.999) and inter-rater (ICC = 0.892) reliabilities; hence, it can be used for various postural assessments with photographic methods in the clinical and research works.

Conflict of Interest
None declared.

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