Validity and Reliability of Electronic Head Posture Instrument for Measurement of Cranio-Horizontal Angle, Craniovertebral Angle and Sagittal Shoulder Angle

Edrish Saifee Contractor[1], Sweety Shah[2], Stuti Shah[3], Parita Dave4

[1]Ph.D. Scholar, Gujarat University, Incharge Principal & Senior Lecturer, MPT (Orthopaedic conditions), Shree Swaminarayan Physiotherapy College, Near G.S.T. Crossing Ranip, Ahmedabad, [2]Ph.D. Guide, Gujarat University, MPT (Cardiopulmonary), Senior lecturer, SBB College of Physiotherapy, V.S. General Hospital, Ahmedabad, Gujarat, India, [3]Lecturer, MPT (Rehabilitation), Shree Swaminarayan Physiotherapy College, Near G.S.T. Crossing, Ranip, Ahmedabad. [4]Lecturer, MPT (Cardiopulmonary), Shree Swaminarayan Physiotherapy College, Near G.S.T. Crossing, Ranip, Ahmedabad

Abstract

Background: Forward head posture (FHP) means that the head is in an anterior position in relation to the postural line and it is considered to coexist with hyperextension of upper cervical spine, flattening of lower cervical spine, rounding of the upper back and elevation and protraction of the shoulders. Because of associated problems, assessment of head posture has become increasingly important in clinical practices in evaluating and designing treatment regimens.

For clinical diagnosis, angle measurements have been utilized as information for evaluating physical characteristics, determining the effects of rehabilitation and preventing injury induced by physical activity. There are various software's available for measuring angles, one of them being Surgimap. In recent years, angle measurements using Electronic head posture instrument (EHPI) have been clinically researched as new angle measurement methods for the forward head posture apart from photographic measurement methods. Thus, this study evaluated the validity and reliability of the EHPI in measuring Head posture angles with Surgimap photograhic method in young healthy subjects.

Methodology: Ethical approval for the study was granted and cross sectional observational study was conducted for validity and reliability at outpatient department. After written consent the subjects were made to understand the purpose of the study. Craniovertebral angle, Cranio-horizontal angle and Sagittal shoulder angle was measured using Electronic Head Posture Instrument and Photographic Method through Surgimap software. The research constituted of three researchers and intra rater reliability, inter rater reliability and validity was analyzed.

Results: Data analysis was done using SPSS 20.0 version and the statistical significance level was set at $p<0.05$. Intra rater reliability was found to be CHA=0. 95, CVA=0.92 and SSA=0.96, Inter rater reliability was found to be CHA= 0.98, CVA= 0.90 and SSA= 0.78. Correlation between different angles was found as CHA=0.95, CVA=0.79 and SSA=0.62.

Conclusion: EHPI is a valid and reliable tool in clinically assessing and evaluating CHA, CVA and SSA

Keywords*: Head Posture, EHPI Smart Tool, Surgimap software, CHA, CVA, SSA*

Corresponding Author:
Dr Edrish Saifee Contractor

Introduction:

Posture is the way a person moves, sits, and walks and is individually unique. It is also defined as the spine

being in a neutral position, with good posture being imperative for improved health.[1] Maintenance of posture involves muscles to contract, which enables the body to remain in both seated and standing positions. However, prolonged sitting or standing can have a detrimental effect on an individual's posture and lead to many postural abnormalities. [2]

Forward head posture (FHP) means that the head is in an anterior position in relation to the postural line. [3] FHP is considered to coexist with hyperextension of upper cervical spine, flattening of lower cervical spine, rounding of the upper back and elevation and protraction of the shoulders.[4] Forward head posture (FHP) is one of the most common cervical abnormalities that predispose individuals toward pathological conditions, such as headache, neck pain, temporomandibular disorders, vertebral bodies disorder, soft-tissue length and strength alteration and shoulder dyskinesis. [5] Because of these associated problems, assessment of head posture has become increasingly important in clinical practices in evaluating and designing treatment regimens.

In physiotherapy practices, angle measurements have been used for assessing physical alignment and articular range of motion. In particular, for clinical diagnosis, angle measurements have been utilized as information for evaluating physical characteristics, determining the effects of rehabilitation, and preventing injury induced by physical activity. For a number of clinical practices, a goniometer is commonly used to measure the joint angles. However, clinical angle measurements using the goniometer have lower reliability and validity. [6] Radiograph measurements (RMs) are strongly recommended for reliable measurements of several joint angles to improve the accuracy. [7] However, radiographic measurement also has disadvantages such as radiation exposure, higher medical costs, and a specialized medical implementation site. Therefore, a non-invasive, simple, and low cost measurement method that has high correlation to RM would be beneficial for various clinical practices.

There are various software's available for measuring angles.[8] Another software used for measuring angles is Surgimap . The present software has turned out to be a boon and is now being utilized in the medical field as well for measuring joint angles. The software is also used for research purposes wherein digital -photo analysis is being done. A previous study has found that Surgimap software is a reliable method for measuring spinal postural angles in adolescents from different views in standing position from digital photographs. [9]

Lau and chiu (2009) have developed an Electronic Head Posture Instrument (EHPI) to measure craniovertebral (CV) angle. Its measuring scale is accurate to one decimal place, and the electronic sensor reads the angle automatically. Measuring craniovertebral (CV) angle is one of the common objective methods in assessing head posture. [10]

A previous study by Lau and chiu (2010) evaluated the criterion-related validity of the Electronic Head Posture Instrument (EHPI) in measuring the craniovertebral (CV) angle by correlating the measurements of CV angle with anterior head translation (AHT) by lateral cervical radiographs in patients with diagnosis of mechanical neck pain and was found to be a valid and reliable tool for measuring the head posture. [11]

In recent years, angle measurements using Electronic head posture instrument have been clinically researched as new angle measurement methods for the forward head posture apart from photographic measurement methods. Head posture can be evaluated by measuring the cranioveterbral angle (CVA), Craniovetebral angle (CHA) and Saggital shoulder angle (SSA).

Thus, this study evaluated the validity and reliability of the EHPI in measuring Head Postural Angles with Surgimap photograhic method in young healthy subjects.

Therefore, the present study aimed to demonstrate the following two research aspects using the measurement of head postural angles provided from the Electronic Head Posture Instrument:

(1) Criterion validity of EHPI and (2) inter-rater reliability and inter-rater reliability of EHPI.

Methodology

A cross sectional observational validity and reliability study was conducted at outpatient department of Shree Swaminarayan Physiotherapy College. Inclusions criteria are Age group between 18 to 22 both gender are included in this study. Participants were

excluded if they had musculoskeletal or neurological pathologies. Based on this criteria, a total number of 50 young healthy indivuals participated in this study by simple random sampling. A written consent was taken from each subject. Following recruitment, the subjects were made to understand the purpose of the study concisely and clearly. Materials used in this study were measuring tape, weighing machine, Digital Camera, EHPI, Surgimap software and reflective adhesive markers. Craniovertebral angle, Cranial horizontal angle and Sagittal shoulder angle was measured using Electronic Head Posture Instrument and Photographic Method through Surgimap software.

Procedure:

The subjects were informed to stand errect with feets width apart. Clothing was rearranged so that neck (C7 spine) and shoulders are exposed; adhesive markers were placed on anatomical point **1.** First point from external canthus of the right eye, **2.** Tragus of the ear **3.** Spinous process of C7 **4.** A midpoint between greater tuberosity of humerus and posterior aspect of acromion process of shoulder. The angles were measured as:

1. Cranio-horizontal angle (CHA)- the angle formed at the intersection of horizontal line through the tragus of ear and external canthus of the eye was measured.

2. Craniovertebral angle (CVA)- the angle formed at the intersection of horizontal line through the spinous process of C7 and tragus of ear was measured.

3. Sagittal shoulder posture (SSA)- the angle formed at the intersection of horizontal line through C7 spinous process and the midpoint of greater tuberosity of humerus and posterior aspect of acromion was measured.

The research constituted of four researchers- who measured angles with Electronic head posture instrument and took lateral view photographs of the upper body for analysis in Surgimap software. For intra-rater validity the angles were measured by the same researcher twice on different sessions. For inter-rater reliability, the angles were measured on the same subject twice by the two researchers. One researcher analyzed the angles in lateral view photograph through surgimap software.

The angles measured by the EHPI which was composed of an electronic angle finder, a transparent plastic base, and a camera stand. The electronic angle finder 'SmartTool,' made by M-D Building Products, was fixed on a transparent plastic base. The combined SmartTool Angle Finder and the plastic base were mounted on a tripod camera. The participant was then asked to stand with his/her left shoulder in front of the EHPI. The participant was instructed to stand comfortably with his/her weight distribution evenly on both feet and to keep the eyes looking straight forward. He/she was then instructed to flex and extend the head three times and then rest it in a comfortable position. The therapist adjusted the EHPI until the two indicator lines were aligned with the markers. Three readings were taken by the researchers and an average was taken.

For photographic method, same angles were measured by placing the markers on respective sites as mentioned above. Images were captured by Digital camera which was mounted on adjustable tripod stand at a distance of 3 m from the subject's shoulder. The same image was inserted in the Surgimap software and angles were measured.

Validity and Reliability of EHPI was analyzed from the data collected.

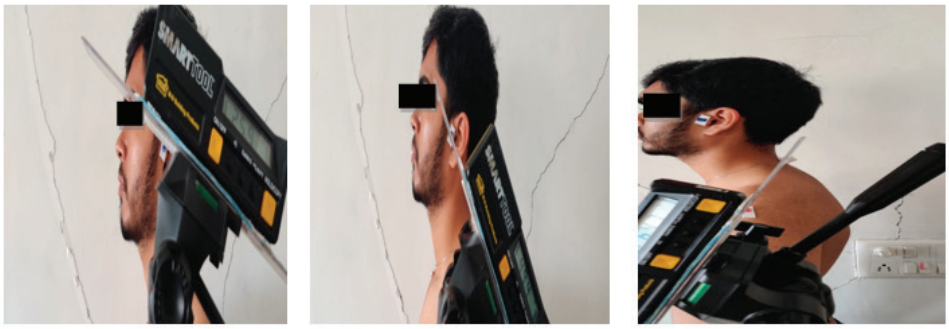

Fig: CHA, CVA and SSA using EPHI Smart Tool

Results

Data analysis was done using SPSS 20.0 version and the statistical significance level was set at $p<0.05$. The study recruited 50 participants, out of which 26 males and 24 females were taken by simple random sampling. The scale from Bland and Altman was used in the classification of the reliability values (≤0.20 poor, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 good, and 0.81–1.00 excellent). [12] Table shows inter-rater reliability of different angles and Table 2 shows the intra-rater reliability of different angles.

TABLE 1:- Inter-rater reliability of EHPI for CHA, CVA and SSA angles

Angle	Icc	Upper Limit	Lower Limit	Significance
CHA	0.98	0.99	0.95	0.001
CVA	0.90	0.97	0.60	0.001
SSA	0.78	0.94	0.13	0.016

At 95% confidence interval ICC for different angles is found as CHA=0.98 (Excellent), CVA=0.90 (Excellent), and SSA=0.78 (Good) for inter-rater reliability.

TABLE 2:- Intra- rater reliability of EHPI for CHA, CVA and SSA angles

Angle	Icc	Upper Limit	Lower Limit	Significance
CHA	0. 95	0.98	0.82	0.00
CVA	0.92	0.98	0.71	0.00
SSA	0.96	0.99	0.85	0.00

At 95% confidence interval ICC for different angles is found as CHA=0.95 (Excellent), CVA=0.92(Excellent) and SSA=0.96 (Excellent) for intra-rater reliability.

The association between different angles measured by Surgimap method and EHPI was explored with Spearman's correlation coefficient. Table 3 shows correlation between different angles measured by Surgimap method and EHPI.

TABLE 3:- Correlation between different angles measured by Surgimap and EHPI

Angle	Spearman's Correlation Value
CHA	0.95
CVA	0.79
SSA	0.62

A Very High Positive correlation was found of CHA, a High Positive correlation was found of CVA and a Moderate Positive correlation was found of SSA. This result suggests that EHPI is a valid tool for measuring head posture angles.

Discussion

This study evaluated the Validity, Inter-rater and Intra-rater reliability for Electronic head posture instrument.

EHPI was found to be a valid tool for assessing head posture. This findings are similar to a previous study by Lau and chiu (2010) who evaluated the criterion-related validity of the Electronic Head Posture Instrument (EHPI) in measuring the craniovertebral (CV) angle by correlating the measurements of CV angle with anterior head translation (AHT) by lateral cervical radiographs in patients with diagnosis of mechanical neck pain and was found to be a valid and reliable tool for measuring the head posture. [13]

The present study showed the high intra rater and high interrater reliability of EHPI. These results are similar to the previous study which showed a high intrarater (0.91–0.93) and interrater reliability (0.92–0.93) for both nondisabled subjects and those with neck pain. [14]

Various disorders of cervical region like-upper cross syndrome, cervical spondylosis, kyphotic posture, PIVD, scoliosis can affect the surrounding musculature leading to postural changes in the cervical region. Amongst these changes, forward head posture is most commonly seen which not only leads to muscle imbalance but also reduces the cervical ROM. Electronic head posture instrument measures the angles similar to the photographic method but the major difference is EHPI is portable whereas the software requires either computer or laptop. The results showed that both the methods; EHPI and Surgimap photographic method has higher agreements on both the angles. These findings indicate the high validity of EHPI for evaluation of head postural angles.

In one of the previous study, the Head Posture Spinal Curvature Instrument (HPSCI), a noninvasive and simple instrument, was designed by Wilmarth and Hilliard. [15] The HPSCI is an inexpensive method to measure CV angle. Willford et al. demonstrated that it produced consistent and stable intrarater results (intraclass correlation coefficient [ICC] =0.9) across days and trials in 27 nondisabled subjects. [16] However, the accuracy of the instrument is limited to whole digits only without decimal places because no marking exists between digits. In contrast, EHPI measuring scale is accurate to one decimal place, and the electronic sensor reads the angle automatically.

Electronic head posture instrument was found to have high validity, inter-rater reliability, and intra-reliability in the present study. Therefore, angle measurements using images taken in a certain distance from the subject were accurate for the definite angle. The results showed what angle measurements using images could use as criterion for validity, and it supported the legitimacy of high-quality previous studies that used photographic method as a criterion for validity.

One of the limitations of lateral photographic imaging to measure head posture is cumbersome and inconvenient to use in clinical practices. On the other hand, EHPI has high clinical benefits, such as being a simple, non-invasive technique and it is cost effective. Thus, EHPI can provide high-quality data in clinical studies and can be used as a criterion of validity for postural angles (CVA, CHA & SSA).

Age can be a major factor that can affect the results. This study included healthy adults aged between 18-24 years. Hence a study including higher and lower age group might be considered for future studies.

Also, in this study female to male ratio, i.e. gender effects as a confounding factor, on the reliability of measurements was not considered. According to the results and limitations mentioned above, it is suggested that studies can be conducted on different age group and gender group to eliminate confounding factors.

Conclusion

There is a strong association of head postural angles measured by EHPI and Surgimap Photographic Method which supports that EHPI can be recommended and is a valid and reliable tool in clinically assessing and evaluating head posture in terms of CHA, CVA and SSA.

Ethical Clearance- Taken from Shree Swaminarayan Physiotherapy College Local Ethics committee

Source of Funding- Self

Conflict of Interest - Nil

References

1. Price, J. Corrective exercise for prolonged static-posture damage. IDEA Fitness Journal. 2010; 7(4): 27-30.
2. Harman, Katherine, Hubley, Cheryl, Butler, Heather. Effectiveness of an Exercise Program to Improve Forward Head Posture in Normal Adults: A Randomized, Controlled 10-Week Trial. Journal of manual and manipulative therapy. 2005; 13: 163-176(14).
3. Yip CHT, Chiu TTW, Poon ATK. The relationship between head posture and severity and disability of patients with neck pain. Manual Therapy. 2007; 1-7.
4. Kendall FP and McCreary EK. Muscles testing and function. (3rd ed.). Baltimore: Williams and Wilkins.1983 pp. 271, 294,298-300.
5. Dr. Edrish Saifee Contractor, Dr. Sweety Shah, Dr. Stuti Jayesh Shah. To study correlation between neck pain and craniovertebral angle in young adults. IAIM, 2018; 5(4): 81-86.
6. Van de Pol RJ, van Trijffel E, Lucas C: Inter-rater reliability for measurement of passive physiological range of motion of upper extremity joints is better if instruments are used: a systematic review. J Physiother, 2010, 56: 7–17.
7. Chapleau J, Canet F, Petit Y, et al. : Validity of goniometric elbow measurements: comparative study with a radiographic method. Clin Orthop Relat Res, 2011, 469: 3134–3140.
8. Damien Bennett, Brian Hanratty, Neville Thompson, David Beverland. Measurement of knee joint motion using digital imaging. Int Orthop. 2009 Dec; 33(6): 1627–1631.
9. NesmaA Helmy MohsenM El-Sayyad. Bulletin of faculty of physical therapy. Intra-rater and inter-rater reliability of Surgimap Spine software for measuring spinal postural angles from digital photographs. January 2015
10. Yip CH, Chiu TT, Poon AT. The relationship between head posture and severity and disability of patients with neck pain. Man Ther. 2008;13(2):148-54.
11. Lau HM, Chiu TT, Lam TH. Measurement of craniovertebral angle with Electronic Head Posture Instrument: Criterion validity. J Rehabil Res Dev. 2010;47(9):911-8.
12. Bland JM, Altman DG. Measuring agreement in method comparison studies. Statistical Methods in Medical Research. 1999; 8: 135-160
13. Lau HM, Chiu TT, Lam TH. Measurement of craniovertebral angle with Electronic Head Posture Instrument: Criterion validity. J Rehabil Res Dev. 2010;47(9):911-8.
14. Cheung Lau HM, Wing Chiu TT, Lam TH. Clinical mea-surement of craniovertebral angle by electronic head pos-ture instrument: A test of reliability and validity. Man Ther. 2009;14(4):363–68.
15. Wilmarth MA, Hilliard TS. Measuring head posture via the craniovertebral angle. Orthop Phys Ther Pract. 2002;14: 13–15.
16. Willford CH, Kisner C, Glenn TM, Sachs L. The interac-tion of wearing multifocal lenses with head posture and pain. J Orthop Sports Phys Ther. 1996;23(3):194–99.