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COMPARISON OF STAINER CEPHALOMETRIC ANALYSIS BETWEEN CONVENTIONAL AND DIGITAL METHODS USING WEBCEPH

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ABSTRACT

Background: Cephalometric analysis plays a critical role in orthodontic diagnosis and treatment planning. The identification of anatomical landmarks from lateral cephalograms is crucial for assessing skeletal and dental relationships[1]. Traditionally, cephalometric analysis is performed manually by orthodontists, which is time-consuming and susceptible to inter-observer variability[2]. The integration of artificial intelligence (AI) in cephalometry has the potential to improve diagnostic efficiency and reduce errors[3]. WEBCEPH is an AI-based cephalometric analysis software that automatically detects cephalometric landmarks, allowing for more accurate and efficient analysis compared to traditional manual methods[4]. This study aims to assess the accuracy of AI-based cephalometric analysis using WEBCEPH compared to conventional cephalometric measurement.

Methods: This study analyzed 30 lateral cephalometric radiographs with good quality and no dental or craniofacial deformities. Each cephalogram was analyzed using both conventional and digital methods. The Stainer cephalometric skeletal, dental, and soft tissue analyses from both methods were compared using independent t-tests and Mann-Whitney.

Outcome: The statistical results indicate that there was no significant difference between conventional and digital methods for all Steiner cephalometric analysis. The WEBCEPH software demonstrated good agreement with conventional methods in cephalometric analysis.

Conclusion: AI-based cephalometric analysis using WEBCEPH provides comparable accuracy to conventional methods, offering a reliable and efficient alternative for orthodontic diagnosis.

INTRODUCTION

Lateral cephalometric radiography has been an essential tool in orthodontics. Cephalometric analysis is a crucial diagnostic tool for treatment planning and evaluating orthodontic patients. Accurate identification of anatomical landmarks on cephalograms is essential for cephalometric analysis[1]. Important anatomical structures need to be identified through landmark identification and manual tracing. Additionally, by offering details regarding a person's morphology, facial growth pattern, craniofacial dimension, skeletal abnormalities, or dentoalveolar, cephalometric analysis can utilized to add dynamic parts of diagnosis to determine a better treatment plan[5]. However, this analysis requires skilled orthodontists and takes considerable time.

Cephalometric analysis can be done by two methods: conventional methods by means of manual tracing and computerized digital methods. The Steiner analysis is the most often utilized cephalometric analysis due to its speed and ease of use. This analysis, which combines Down, Wendell Wylie, Brodie, Rickett, Thomson, Riedel, and Holdaway procedures, is among the most widely used analyses for orthodontic treatment planning. [6,7]

Digitization technology, artificial intelligence (AI) refers to the study of systems that perform tasks requiring human intelligence using different computational algorithms[2,3]. In recent years, the use of AI in medicine and healthcare for patient diagnosis and treatment has become an intriguing topic[8]. This has led to the development of AI technology applications in dentistry to automatically digitize anatomical structures in lateral cephalometric radiography. With this program, automated cephalometric analysis, including diagnostic and analytical imaging tasks, can be performed using AI technology. However, to the best of our knowledge, only a few recent studies have explored the performance of AI in cephalometric analysis beneficial to clinicians. Previous studies on deep learning algorithms have reported that AI accurately detects cephalometric landmarks[9,10]. By its numerous appealing features that might make orthodontic treatment planning and patient record gathering easier, WEBCEPH is an AI-based orthodontic and orthognathic online platform that has recently gained popularity. These consist of automatic image archiving, visual treatment simulation, automatic superimposition, cephalometric tracing, cephalometric analysis, and a photo gallery. Furthermore, WEBCEPH enables both automatic measurement computation and human landmark editing.[4]

To further explore the application of this technology in clinical orthodontics, clinical performance results of cephalometric analysis are needed. The aim of this study is to evaluate the accuracy of digital cephalometric analysis compared to conventional cephalometric measurements.

RESEARCH METHOD

The object of this study was the X-rays of patients treated in the Installation of Department of Orthodontics Integrated Dental Hospital Universitas Muhammadiyah Semarang, men or women since Januari until November 2024 and possessed a lateral cephalometric film and digital cephalogram. The necessary tools consist of a laptop equipped with the WEBCEPH application v.1.5.0 premium (a web-based program for cephalometric analysis), one box of illuminators, a 30 cm ruler, a 180-degree protractor, 30 sheets of acetate paper, two HB pencils, three OHP markers (red, blue, and black), an eraser, and adhesive tape.

The inclusion criteria for this study were (1) fully erupted permanent teeth and (2) the absence of extensive prosthetic restorations such as crowns or metal bridges on molar teeth and implants. The exclusion criteria included (1) missing multiple teeth or extensive prosthetic restorations such as crowns or metal bridges on molar teeth and implants and (2) a history of orthodontic treatment or orthognathic surgery. Conventional lateral cephalograms from 30 orthodontic patients were analyzed using an illuminator for conventional cephalometric analysis and imported into WEBCEPH for digital analysis. Steiner cephalometric analysis using conventional techniques was performed by tracing the x-rays on acetate paper. The same X-ray was converted into digital format and the file was inserted into WEBCEPH that had previously calibrated between manual and digital cephalogram on the software. WEBCEPH automatically generates cephalometric tracing, including angle measurements and analysis values. Although the AI in WebCeph can perform analyses quickly and accurately, it is still advisable for researchers or orthodontic professionals to conduct a check and recheck process. This is crucial because factors such as image quality, anatomical landmark positioning, and individual variations can affect the accuracy of the AI-generated analysis. The conventional assessment by two people who had been previously calibrated. Images were checked independently by each examiner, and the results of the evaluated features were then compared. In case of disagreement, the drawings are re-evaluated together to reach a consensus. The degree of agreement between the two authors was assessed based on Cohen kappa statistics. On each sample cephalogram, the determination of Steiner's reference points, lines and planes dragging, angle and distance measurement using protractors were conducted.

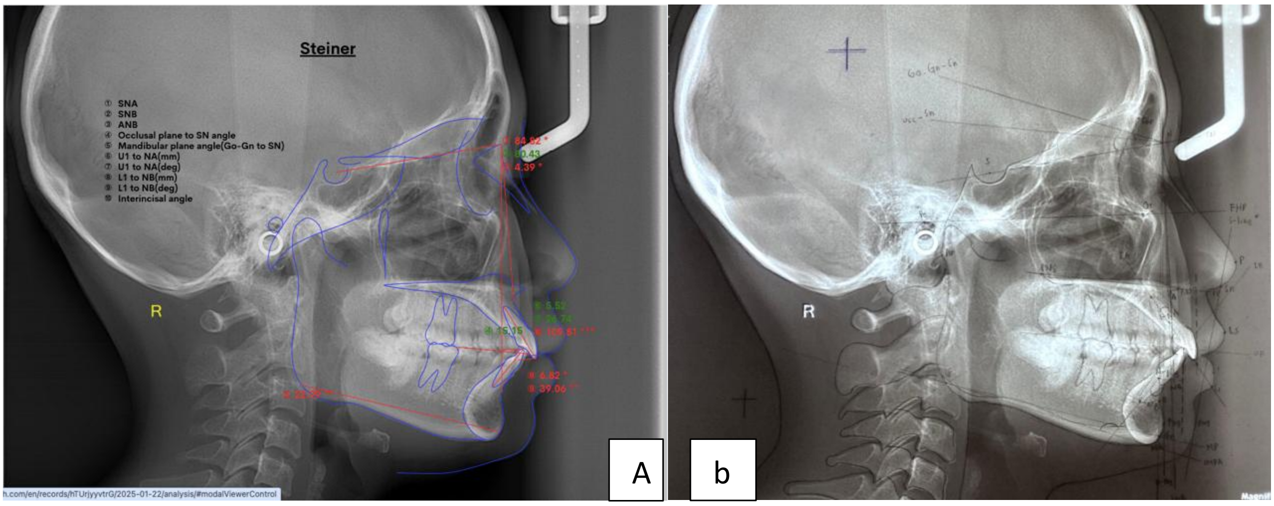

Figure 1. Results of strainer analysis using WEBCEPH (A) and conventional (b)

After Steiner cephalometric analysis measurements were obtained in both conventional and digital methods using WEBCEPH, the results were then inserted into the table and then analyzed statistically.

RESEARCH FINDINGS

This study was conducted on the x-rays of patients treated in the Installation of Department of Orthodontics Integrated Dental Hospital Universitas Muhammadiyah Semarang, men or women since Januari until November 2024 and possessed a lateral cephalometric film and digital cephalogram. It involved 30 cephalometric samples from patients. Cephalometric analysis was then performed using conventional techniques and digital techniques by using application WEBCEPH software to compare any discrepancy between the two methods. The Kappa value for both researchers from 10 strainer variables had a value between 0.4 and 0.7 so that the similarity of assessments between raters was included in the good category. Therefore, the data normality test of both analysis groups was conducted, with the following results in Table 1.

Table 1. Data Normality Test

Variable	Group	n	p-value	Data Distribution	Comparison Test
SNA	WEBCEPH	30	0,184	Normal	Independent t test
	Conventional	30	0,053	Normal	
SNB	WEBCEPH	30	0,694	Normal	Independent t test
	Conventional	30	0,197	Normal	
ANB	WEBCEPH	30	0.709	Normal	Independent t test
	Conventional	30	0.204	Normal	
Mandibular Plane to SN	WEBCEPH	30	0.542	Normal	Independent t test
	Conventional	30	0.243	Normal	
Occlusal to SN	WEBCEPH	30	0.898	Normal	Independent t test
	Conventional	30	0.942	Normal	
INA (mm)	WEBCEPH	30	0.240	Normal	Mann Whitney test
	Conventional	30	0.005	Abnormal	
INA Angle	WEBCEPH	30	0.838	Normal	Independent t test
	Conventional	30	0.988	Normal	
INB (mm)	WEBCEPH	30	0.261	Normal	Mann Whitney test
	Conventional	30	0.050	Abnormal	
INB Angle	WEBCEPH	30	0.487	Normal	Independent t test
	Conventional	30	0.183	Normal	
Inter Incisal	WEBCEPH	30	0.488	Normal	Independent t test
	Conventional	30	0.208	Normal	

Note: normality test is obtained by the method of Shapiro wilk, normal distribution of data if p>0.05

Based on Table 1, it was known that 8 out of 10 cephalometric variables showed normal data distribution in both groups (p>0.05), while two other variables, the conventional INA (mm) and INB (mm) variables group, showed abnormally distributed data, (p <=0.05). Thus, the eight variables with both normally distributed data groups were analyzed using t-test to compare two independent samples, while the comparisons of INA (mm) and INB (mm) were conducted using Mann Whitney test. The results of the comparison tests are presented in Table 2.

Table 2 showed that all 10 cephalometric variables showed no significant difference between the groups analyzed conventionally and the groups analyzed using WEBCEPH, which is indicated by the p-value comparison test results that exceeded the critical point of 0.05.

Table 2. Cephalometric Analysis Comparative Test for Each Variable

Variable	Group	n	Mean (SD)	t count/ MW	p-value
SNA	WEBCEPH	30	85.4110	.739[a]	0,463
	Conventional	30	84.7333		
SNB	WEBCEPH	30	80.2967	.283[a]	0,778
	Conventional	30	80.0000		
ANB	WEBCEPH	30	5.0163	.549[a]	0,585
	Conventional	30	4.7333		
Mandibular Plane to SN	WEBCEPH	30	30.8537	-.349[a]	0,728
	Conventional	30	31.4333		
Occlusal to SN	WEBCEPH	30	15.2237	-.381[a]	0,704
	Conventional	30	15.6667		
INA (mm)	WEBCEPH	30	4.4870	-.518[b]	0,604
	Conventional	30	5.0333		
INA Angle	WEBCEPH	30	23.2667	-.500[a]	0,619
	Conventional	30	24.2333		
INB (mm)	WEBCEPH	30	7.5313	-.933[b]	0,351
	Conventional	30	7.9667		
INB Angle	WEBCEPH	30	32.7697	-.214[a]	0,831
	Conventional	30	33.1333		
Inter Incisal	WEBCEPH	30	118.0187	.420[a]	0,676
	Conventional	30	116.8667		

Note: a) Independent t-test, b) Mann Whitney test, significant differences if the p-value <0.05

DISCUSSION

The cephalometric analysis is one of the analyses used in orthodontic treatments for diagnosis and treatment planning. There is no significant difference between the findings of the analysis carried out by tracing conventionally and digital methods using WEBCEPH, according to research on the differences of Steiner cephalometric analysis between conventional method and computerized method using WEBCEPH. With AI-powered features, WEBCEPH enhances efficiency in diagnosis and treatment planning, reduces manual errors, and accelerates case evaluations. The p-value comparison test findings exceeded the critical limit of 0.05, indicating that there were no significant differences between the two groups (Table 2).

This was consistent with Erkan's statements that the use of computer software for cephalometric analysis assisted clinicians to measure angles and distances automatically, removing the need for errors when drawing lines between landmarks or using a protractor. The results indicated no difference between the digital method and the tracing method analysis. This demonstrates how the use of computer software for cephalometric analysis can take the place of traditional methods. However, according to Cavdar's research, there are drawbacks to traditional methods, such as their lengthy processing times and potential for calculation errors when identifying landmarks, angles, and distances. However, to assess the differences between cephalometric analysis using traditional tracing and digital approach, in this example utilizing the WEBCEPH, more research using various analytic methods with many samples was needed to get more meaningful results.

CONCLUSION

This study concluded that there was no significant difference between the digital method employing WEBCEPH and the traditional tracing method for Steiner cephalometric analysis.

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