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Measurement of Steiner analysis conventionally and digitally at the age of 12-18 years at RSGM-P Universitas Airlangga

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Abstract

Background: Malocclusion is generally not a pathological process but a deviation process that occurs in the growth and development of the craniofacial system starting in childhood, affecting function and aesthetics, thereby impacting quality of life and social interactions. Lateral cephalometry is used to study individual growth changes within a population. Lateral cephalometric analysis measurements can be performed using conventional or digital methods. With technological advancements, several measurement methods using digital and computer applications for cephalometric analysis have been developed. Consequently, digital measurement methods are gradually replacing conventional methods.

Purpose: To analyze the results of conventional and digital Steiner analysis measurements on cephalometric radiographs in individuals aged 12-18 years.

Methods: A total of 50 lateral cephalometric samples (19 males; 31 females) were selected according to inclusion and exclusion criteria from patients in the Department of Pediatric Dentistry. Steiner analysis was used for each radiographic measurement. The SNA, SNB, and ANB angles were first measured conventionally, followed by digital methods using the Android-based OneCeph application. The results obtained from both methods were then compared.

Results: The data used in this study are not normally distributed; therefore, the non-parametric Mann-Whitney test is used to analyze the data. There is no significant difference between the results of Steiner analysis measurements using conventional and digital methods (OneCeph app).

Conclusion: The results of this study indicate that there is no difference between the Steiner analysis measurement results for individuals aged 12-18 years using the conventional method (hand-tracing) and the digital method (One-Ceph app).

Keywords: Malocclusion; Cephalometry; OneCeph; Steiner Analysis; Good Health

1. Introduction

Malocclusion is one of the common problems in pediatric dentistry and ranks third highest after caries and periodontal disease [1]. Malocclusion is a condition that deviates from the normal relationship of teeth within the same arch and to the teeth in the opposing jaw arch [2]. Malocclusion is generally not a pathological process but a deviation process that occurs in the growth and development of the craniofacial system starting in childhood, affecting function and aesthetics, thereby impacting quality of life and social interactions [3,4].

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The prevalence of malocclusion in Indonesia is still very high, around 80% of the population. Based on the results of research by the Health Research and Development Agency of the Ministry of Health of the Republic of Indonesia in 2019, the prevalence of malocclusion cases in children aged 13-15 years was 15.6% [5]. According to research by Lagana et al. [6] on children aged 7-15 years with poor oral hygiene, about 80% of them suffer from malocclusion, whether it is class I, class II, or class III malocclusion. According to Moyers, the Angle classification system is the first universally accepted classification system and remains the standard used today. In 1899, Edward Hingley Angle divided malocclusion classification into three categories: Angle Class I, Class II, and Class III [2].

In managing malocclusion cases, the success of treatment is based on accurate and comprehensive diagnosis and treatment planning. Careful examination is required, including clinical examination, model analysis, radiographic analysis, and facial profiling. Radiographic analysis is one of the supporting examinations that can help establish a diagnosis by providing information about oral cavity structures that cannot be seen directly by the eye. The radiographic technique used in malocclusion treatment is extraoral radiography, one of which is the frequently used lateral cephalometric technique [7].

Lateral cephalometry is used to study individual growth changes within a population [8]. Several facial analysis techniques are available, one of the most well-known and frequently used in malocclusion treatment is the Steiner analysis developed in the 1950s by Cecil C. Steiner [9]. Steiner divided his analysis method into three categories: skeletal analysis, dental analysis, and soft tissue analysis. Skeletal analysis involves the relationship between the upper and lower jaws to the cranial base. Dental analysis involves the relationship between the upper and lower incisors [10]. In his analysis, Steiner chose the SN line (S=sella tursica and N=nasion) as the reference plane because these two points are located on hard tissues, making them easily identifiable on radiographs [11]. Steiner's skeletal sagittal analysis provides a comprehensive assessment of the anteroposterior relationship of the jaws and determines the facial skeletal pattern of each individual, applicable to various age groups. This can help dentists determine and predict feasible treatment plans for each individual [12].

Lateral cephalometric analysis measurements can be performed using conventional or digital methods. Previously, conventional cephalometric analysis measurement was the only available method and became the gold standard for obtaining cephalometric measurement results and the required angular and linear measurements for their interpretation [13]. However, with technological advancements, several measurement methods using digital and computer applications for cephalometric analysis have been developed [14]. Consequently, digital measurement methods are gradually replacing conventional methods [13].

Based on the above explanation, there is still limited information and research related to the comparison of lateral cephalometric measurement results using conventional and digital methods, especially in Indonesia. Therefore, when transitioning to digital methods, it is essential to determine whether the results will be approximately the same or different from conventional methods. This study aims to compare the differences in calculation or analysis results using Steiner analysis conventionally and digitally on lateral cephalometric radiographs of individuals aged 12-18 years at RSGM-P Universitas Airlangga.

2. Material and methods

This study on the Measurement of Steiner Analysis Conventionally and Digitally in the Age Group of 12-18 Years at RSGM-P Universitas Airlangga employs an observational analytic research design with a cross-sectional study approach. The subjects of this research are lateral cephalometric radiographs of individuals aged 12-18 years at the Dental and Oral Hospital of Education (RSGM-P) Universitas Airlangga. Inclusion criteria include lateral cephalometric radiographs of individuals aged 12-18 years; fully erupted permanent teeth; no anomalies in tooth shape, size, and number; no prosthodontic restorations such as implants and crowns on molars; and patients in centric occlusion. Exclusion criteria include poor-quality radiographs indicated by artifacts disrupting the identification of anatomical landmarks and congenital anomalies. The study uses total sampling, including all lateral cephalometric radiographs of individuals aged 12-18 years at RSGM-P Universitas Airlangga from July 2022 to July 2023 that meet the inclusion and exclusion criteria. The study will be conducted at RSGM-P Universitas Airlangga from July 2023 to October 2023. Data collection will be recorded using Microsoft Excel and processed using IBM SPSS version 26 for Windows. Overall data processing will be conducted on IBM SPSS. Normality and homogeneity tests will be conducted on the data. The Kolmogorov-Smirnov Test will be used for normality testing, and Levene's Test will be used for homogeneity testing. If the data is normally distributed and homogeneous, a Paired T-Test will be performed; otherwise, a Mann-Whitney Test will be conducted.

3. Results

The samples in this study are lateral cephalometric radiographs of individuals aged 12-18 years at RSGM-P Universitas Airlangga from July 2022 to July 2023. Characteristics based on gender and age can be analyzed univariately with the following results.

Table 1 Characteristics of The Research Sample

Characteristics	*n*	Percentage (%)
Gender		
Male	19	38.0%
Female	31	62.0%
Age		
12	16	32.0%
13	5	10.0%
14	5	10.0%
15	4	8.0%
16	9	18.0%
17	6	12.0%
18	5	10.0%

Based on the table above, it can be seen that, in terms of gender, the number of female samples in the study is higher than that of male samples. In terms of age, the largest proportion is the sample aged 12 years (32.0%).

Lateral cephalometric measurements using Steiner Skeletal Sagittal analysis are measured using two methods: conventional and digital.

3.1. Results of Conventional Steiner Analysis Measurements

The results of lateral cephalometric measurements using conventional Steiner Skeletal Sagittal analysis can be measured based on three angles: SNA angle, SNB angle, and ANB angle. Descriptively, the measurement results can be presented in Table 2 as follows.

Table 2 Conventional Steiner Analysis Measurement Results

Angle	*n*	*Mean ± SD*
SNA	50	83.90 ± 3.42
SNB	50	83.38 ± 3.54
ANB	50	0.52 ± 2.76

Based on the table, it can be seen that the average results of lateral cephalometric measurements using conventional Steiner Skeletal Sagittal analysis for the SNA angle are 83.90, the SNB angle is 83.38, and the ANB angle is 0.52.

3.2. Results of Digital Steiner Analysis Measurements

The results of lateral cephalometric measurements using digital Steiner Skeletal Sagittal analysis can be measured based on three angles: SNA angle, SNB angle, and ANB angle. Descriptively, the measurement results can be presented in Table 3 as follows.

Table 3 Digital Steiner Analysis Measurement Results

Angle	*n*	*Mean ± SD*
SNA	50	83.91 ± 3.18
SNB	50	83.59 ± 3.42
ANB	50	0.31 ± 2.92

Based on the table, it can be seen that the average results of lateral cephalometric measurements using digital Steiner Skeletal Sagittal analysis for the SNA angle are 83.91, the SNB angle is 83.59, and the ANB angle is 0.31.

3.3. Normality test

The normality test is conducted to determine whether the research data follows a normal distribution. The normality test is conducted using the Kolmogorov-Smirnov Test. Data is considered normal if the significance value is above 0.05 ($p>0.05$). Based on the results of the normality test, it can be seen that the lateral cephalometric measurement data using Steiner analysis that is normally distributed is found in the SNA and SNB angles in digital measurements ($p>0.05$). The other groups are not normally distributed ($p<0.05$). Based on the normality test results, the comparative analysis of conventional and digital lateral cephalometric measurement results is conducted using a nonparametric approach, namely the Mann-Whitney Test.

3.4. Comparison of Conventional and Digital Steiner Analysis Measurement Results

The comparison of conventional and digital Steiner Skeletal Sagittal analysis measurement results can be analyzed using the Mann-Whitney Test with the following results.

Table 4 Comparison of Measurement Results

Angle	Method	*Mean ± SD*	*p*
SNA	Digital	83.91 ± 3.18	0.898
	Manual	83.90 ± 3.42	
SNB	Digital	83.59 ± 3.42	0.780
	Manual	83.38 ± 3.54	
ANB	Digital	0.31 ± 2.92	0.676
	Manual	0.52 ± 2.76	

Based on the results of the Mann-Whitney test, it can be seen that there are no significant differences in the measurement results of the Steiner Skeletal Sagittal analysis between conventional and digital methods for the SNA, SNB, and ANB angles. For the SNA angle, the average digital measurement is 83.91, whereas the manual measurement is 83.80. This indicates that the average SNA angle in digital and manual measurements is almost the same. The obtained significance value is 0.898 ($p>0.05$), indicating no significant difference in Steiner analysis results between conventional and digital methods for the SNA angle. For the SNB angle, the average digital measurement is 83.59, whereas the manual measurement is 83.38. This indicates that the average SNB angle in digital and manual measurements is almost the same. The obtained significance value is 0.780 ($p>0.05$), indicating no significant difference in Steiner analysis results between conventional and digital methods for the SNB angle. For the ANB angle, the average digital measurement is 0.31, whereas the manual measurement is 0.52. This indicates that the average ANB angle in digital and manual measurements has a difference of 0.19. The obtained significance value is 0.676 ($p>0.05$), indicating no significant difference in Steiner analysis results between conventional and digital methods for the ANB angle.

4. Discussion

Lateral cephalometric radiographic examination plays an important role in dental practice, particularly in orthodontics and pediatric dentistry. Accurate measurements and interpretations of lateral cephalometry are required to diagnose

malocclusion and plan treatment. Conventional lateral cephalometric measurements are gradually being replaced by digital methods due to continuous technological advancements [15].

In recent years, there has been an increase in the use of applications for lateral cephalometric measurement using smartphones, with various available applications. Several studies have mentioned that digital cephalometric measurements show accurate results and can be used as an alternative to manual methods [16,17].

Conventional lateral cephalometric measurement is a method that has been used previously and remains the gold standard in dental practice. Conventional methods are also useful for students and beginners to learn and gain knowledge of all cephalometric landmarks. However, the efficiency of this method has declined because the process is time-consuming, and its margin of error tolerance depends on the accuracy of measurements taken directly using a protractor and ruler [16,18]. Conventional methods also have limitations related to the operator's ability to perform measurements, which can affect measurement accuracy [19].

The OneCeph application was used to measure lateral cephalometry digitally in this study. OneCeph can be downloaded from the Google Play Store on Android phones. OneCeph has several programs for commonly used analyses such as Steiner, Downs, Tweed, Ricketts, and others. This application was developed by Dr. M. Pavan Kumar, Professor of Orthodontics at Kamineni Institute of Dental Sciences, Narketpally, India. Its ability to simplify complex measurements, making them easy to use, minimize time wasted during cephalometric analysis, provide references for structures and points used, store data and access patient information, and operate without an internet connection are advantages of using this application [16].

Digital measurement provides a better view of points that are difficult to determine, such as incisal edges obscured by tracing paper or insufficient contrast on radiographs. Digital methods have the advantage because cephalometric images can be enhanced by adjusting brightness and contrast, making it easier to find some landmarks, thus resulting in more accurate cephalometric analysis [18].

In this study, the measurement results of both methods showed no significant differences. The Steiner analysis was chosen for this study because it is well-known and often used for lateral cephalometric analysis [17]. Skeletal sagittal analysis using SNA, SNB, and ANB angles was measured using both conventional and digital methods.

In previous studies, Mohan et al. [17] stated that the comparison of Steiner analysis measurement results using conventional and digital methods showed no significant differences. The use of the simple, reliable, and accurate OneCeph application as an alternative to manual measurements can be easily accessed on smartphones without an internet connection, saving time and resources. In line with this statement, Zamrik & Iseri [20] mentioned that the mean comparison of measurement results using conventional and digital methods (OneCeph) was below 1 (one) degree, indicating that the differences between these methods are clinically insignificant.

Barbhuiya et al. [21] found that measurement results using the OneCeph application for the SNA angle showed statistically significant differences. The researchers stated that there might be inconsistencies in identifying Point A in the application. Other research has shown that identifying Point A is difficult because soft tissue near the anterior nasal spine can cast shadows on X-ray results, making it difficult for operators to identify Point A [22].

Zamrik & Iseri [20] stated that the measurement results for the SNB angle and several other measurements (N- I to Pog, U1-A point, U lip to S line, and nasolabial angle) using the OneCeph application showed statistically significant differences. This might be because the Nasion is difficult to determine when the nasofrontal suture is not clearly visualized. Additionally, Point B is located on a curve, making it likely that operators can make measurement and determination errors at Point B.

In recent years, many other applications such as CephX, OpenCeph, WebCeph, and Smile-Ceph have become accessible via smartphones and computers. Several studies on these applications have mentioned that they are accurate and reliable in obtaining compatible cephalometric measurements. Although becoming an alternative to conventional methods, digital technological advancements cannot replace the important role of dentists in integrating clear and precise diagnostic records [18,23-24]. Goracci et al. [25] demonstrated good reliability for all cephalometric measurements on the Smile-Ceph application operated using an iPad. One drawback of this application is that it can only be accessed on iPads and iOS software.

Livas et al. [22] mentioned in their study that they provided a detailed analytical assessment of the validity and reliability of linear and angular cephalometric measurements obtained from the CephNinja and OneCeph applications

compared to Viewbox. The study results showed that OneCeph had higher validity than Viewbox, while CephNinja was the best alternative to Viewbox in terms of reliability. When looking at the measurement results of OneCeph and CephNinja compared to Viewbox, CephNinja measurements showed significant differences from OneCeph, indicating that OneCeph has higher validity. On the other hand, for reliability, CephNinja measurement results showed recommended reliability values compared to OneCeph.

In this study, measurements using both methods were performed by the same examiner. The sample size used in this study was 50 lateral cephalometric radiographs that met the inclusion criteria. Measurements were conducted with a 1-hour interval per cephalogram, and a maximum of 5 measurements were performed per day to avoid eye fatigue, which can cause errors in landmark identification and disrupt data collection, potentially affecting the study's reliability [16,26].

The comparison of mean measurement results of Steiner skeletal sagittal analysis from both methods was conducted and showed no significant differences. The research data is represented in the form of mean and standard deviation. Data normality was analyzed using the Kolmogorov-Smirnov Test, and the data was found to be non-normally distributed. A non-parametric test was used for data analysis. The Mann-Whitney Test was used to examine the mean differences in measurement results of both methods. The significance level at $p>0.05$ indicates no significant differences.

This study has some limitations due to the researcher's constraints, such as measurements being performed by only one examiner and the study being limited to using only one digital application, namely OneCeph.

5. Conclusion

The results of this study indicate that there is no difference between the Steiner analysis measurement results for individuals aged 12-18 years using the conventional method (hand-tracing) and the digital method (One-Ceph app).

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Dental Hospital Airlangga University Health Research Ethical Clearance Commission has studied the proposed research design carefully and certified the research.

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