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A Comparison of Reproducibility of Artificial Intelligence Assisted Cephalometric Analysis Using WebCeph^{TM} on Android and iOS Operating Systems - A Short Study

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Abstract: ***Introduction**: Cephalometric radiography is a crucial tool diagnosis, prognosis, treatment planning and evaluation. Cephalometric analysis employing computerised software is becoming very popular as a result of recent technological advancements and a spike in the usage computer and Artificial Intelligence (AI) in the field of orthodontics. **Aim**: The aim of this study is to investigate the reproducibility of the linear and angular measures obtained from the WebCephTM cephalometric analysis software when performed on two different operating systems (Android and iOS). **Materials and Methods**: 15 pretreatment digital lateral cephalograms were randomly selected based on inclusion criteria. Web - based fully automated tracing and Steiners analysis was done using WebCeph^{TM}cephalometric analysis application on iOS and Android based smartphones seperately and compared. Data was analyzed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL) and level of significance was set at $p<0.05$. **Result**: The Mann Whitney U test reported no statistically significant difference between the groups regarding any of the selected variables ($p>0.05$). CONCLUSION: The results showed good reproducibility of the linear and angular measures obtained from the WebCephTM cephalometric analysis software on both operating systems (Android and iOS).*

Keywords: Digital, Cephalometrics, AI, WebCeph, Smartphone

1. Introduction

In 1931, Broadbent in the USA and Hofrath in Germany introduced the technique of radiographic cephalometry. Since then, researchers and clinicians have adopted this valuable tool and used routinely to analyse the underlying dentofacial relationships. [1 - 3]

In orthodontics, cephalometric radiography is a crucial tool. It is required for researching the dentofacial skeleton's growth and development, making diagnoses, formulating treatment plans, and assessing therapy outcomes. According to conventional wisdom, manual tracing is the "Gold standard" for cephalometric study. But, it is much time consuming. It is also associated with various errors which occur due to improper tracing, inaccurate landmark recognition, measurement and calculation along with errors associated with human fatigue. Cephalometric analysis employing computerised software is turning very popular as a result of recent technological advancements and a spike in the usage computer in the field of orthodontics. These initiatives save time and eliminate numerous errors that occur with manual tracing. Multiple analyses may be completed extremely quickly when utilising computerised cephalometry, which is an additional advantage. [4]

Recently released smartphone apps (i. e., software programmes designed to operate on smartphones and tablets) enable automatic calculation of cephalometric data, much like semiautomatic computer - based software. Orthodontic applications are currently available for patients or clinicians. They advertise meetings, goods, diagnostics, and practise management in the field of orthodontics. Additionally, they perform the roles of treatment simulators, progress monitors, and elastic wear reminders. The measurement properties of apps require to be continuously monitored due to the rapid rise of apps and the lack of an organised technique to determine the validity and reliability of mobile apps. [5]

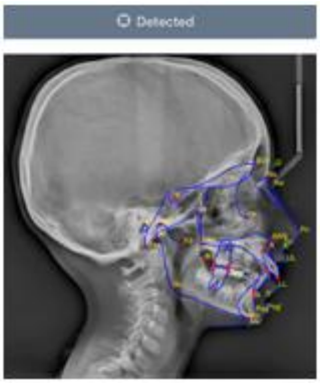
"WebCephTM" (Assemble Circle Corp., Gyeonggi - do, Republic of Korea), a two - dimensional (2D) artificial intelligence - based cephalometric software, was developed and made accessible as a web - based platform for personal computers and as a smartphone phone application. The automatic landmark detection achievable by AI (artificial intelligence) makes WebCephTM unique. Artificial intelligence is a useful tool to reduce the time needed for final diagnosis and treatment planning. As errors may occur during landmark detection, it is vital to verify this software's reliability and reproducibility when compared to to that of previously certified digital software and the conventional manual tracing. The WebCephTM app's AI - based landmark digitization was put to the test in several experiments, and its accuracy was compared to that of manually tracing landmarks and to previously certified digital software. The repeatability of the outcomes was found to be good. [6]

Aim

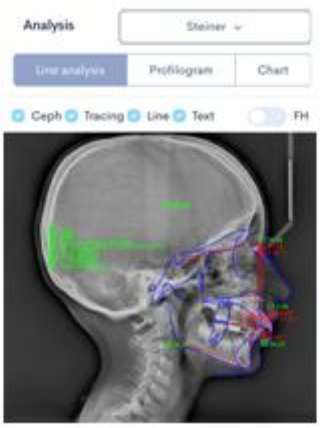
The aim of this study is to investigate if there would be a statistically significant difference between the linear and angular measures obtained from the WebCephTM cephalometric analysis software when performed on two different operating systems (Android and iOS).

2. Materials and Methods

This study was done in the department of Orthodontics and Dentofacial Orthopaedics, Kannur Dental College, Kannur. A total of 15 pretreatment digital lateral cephalograms were randomly selected. Good quality radiographs with good contrast, sharp edge images, clarity, easy landmark identification, were included for the study. Lateral cephalograms of patients with craniofacial deformities, excess soft tissue that could interfere with locating anatomical points, positional errors as reflected by ear rod markers and cephalograms in which landmarks could not be identified because of motion, resolution disparity or lack of contrast were excluded from the study. No differentiation was made for chronological or skeletal age, gender, type of malocclusion and skeletal pattern. Patient identifiers (ie, name, age, gender, and date of examination) was cropped out of the original lateral cephalograms to maintain patient privacy.



All the cephalograms selected were obtained using the same radiographic unit and with the same magnification, taken according to a standardized protocol. Eight angular and two linear measurements originating from the Steiner cephalometric analysis, the prevailing cephalometric analysis in orthodontic practices, all available in the analysis protocols of app, was selected for the tracing procedures. The angles included SNA, SNB, ANB, mandibular plane angle (SN - GoGn), occlusal plane angle, upper incisor to NA (U1 to NA), lower incisor to NB (L1 to NB), interincisal angle. The linear measurements included U1 to NA and L1 to NB.



The WebCephTM (Assemble Circle Corp., Gyeonggi - do, Republic of Korea) app was downloaded from the play Store in android and App store in iOS smartphones separately. The app was signed up using two different credentials on both smart phones. Patient profiles were created in the system and digital images of cephalogram were uploaded to respective profiles in both platforms. Then, using the AI Digitization feature of the WebCeph automated landmark identification was done and Steiners analysis by the software was done. Image was calibrated using the ruler of 30 mm displayed on screen which has to be fitted to the calibration ruler present on the digital image of cephalogram. Then, the cephalometric measurement values obtained were downloaded in portable document format (pdf) and the measurements were entered into the same Numbers spreadsheet and used for the analysis. Same process was done for all the 15 digital cephalograms.

Statistical Analysis

Data was analyzed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL) and level of significance was set at $p<0.05$. Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using Shapiro Wilkinson test. Inferential statistics to find out the difference between the groups was done using MANN WHITNEY U TEST. Non parametric test was used as the data was found to be non normally distributed

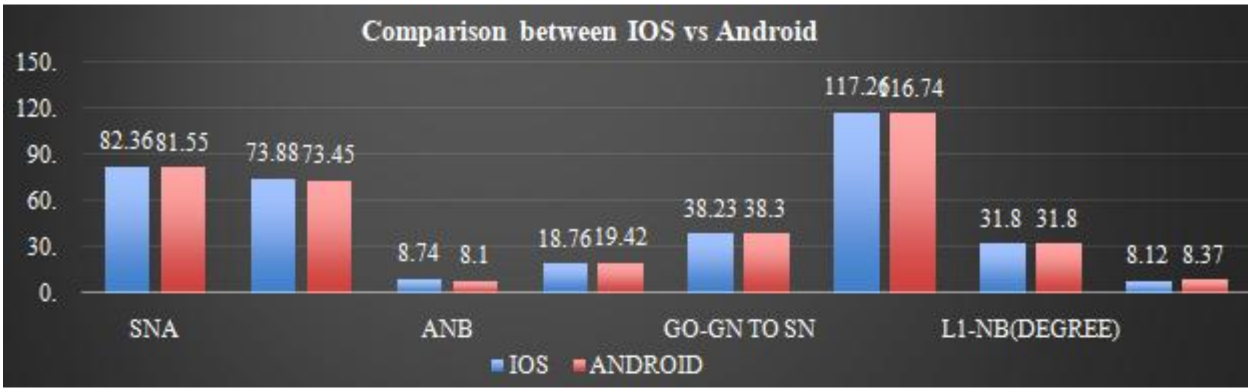
3. Result

The Mann Whitney U test reported no statistically significant difference between the groups regarding any of the above mentioned variables ($p>0.05$).

Table 1: Comparison of Variables – Between Group

	Group 1 IOS	Group 2 Android	Z Value	P Value
SNA	82.36 ± 2.065	81.55 ± 2.298	0.95	0.35
SNB	73.88 ± 1.70	73.45 ± 1.940	0.32	0.69
ANB	8.74 ± 1.142	8.1 ± 1.230	1.47	0.15
Occlusal Plane to SN	18.76 ± 3.29	19.42 ± 3.63	0.53	0.59
GO - GN TO SN	38.23 ± 2.038	38.295 ± 2.748	0.23	0.87
Inter Incisal Angle	117.26 ±6.446	116.74 ± 6.458	0.65	0.59
L1 - NB (Degree)	31.80 ± 3.720	31.8 ± 3.52	0.14	0.94
L1 - NB (MM)	8.12 ± 0.746	8.37 ± 0.722	0.93	0.35

*P<0.05 is statistically significant (Shapiro Wilkinson test, $p<0.05$)



4. Discussion

The lateral cephalometric radiograph is a significant documentation tool for the diagnosis of anteroposterior and vertical discrepancies and the assessment of the relationship between soft tissue and dental structures. [7] Therefore, the procedure used for cephalometric analysis needs to be precise, secure, and highly consistent. [8]

The orthodontic practitioners are now relying on artificial intelligence (AI) to aid in making accurate diagnoses and establishing appropriate treatment plans. In recent decades, many forms of digital cephalometric software and apps have become more prevalent in the field of orthodontics. AI technologies have been used in cephalometric analysis to make linear and angular measurements as well as, more recently, to identify anatomic landmarks. [9, 10]

Assessing the accuracy of this software is essential since, in general, an orthodontist who utilises these technological tools in routine clinical practise relies on the data finally provided by the platform. This is of utmost importance given that the dependability of completely automated AI - assisted software has been the subject of conflicting research in the literature, with some arguing for good reliability [9 - 12] and others revealing important differences from manual land marking techniques [13, 14]. . On the other hand, the majority of research revealed that completely automated AI - assisted software had good accuracy when compared to other digital computer software [15, 16]. However, some discrepancies in particular parameters were discovered; as a result, operator supervision and potential adjustment was required [14]. It is generally accepted that a landmark identification is accurate when the inaccuracy is less than 0.59 mm on the horizontal axis and less than 0.56 mm on the vertical axis. [17]

Since linear and angular measurements ultimately determine the diagnosis and treatment plan, cephalometric measurements were employed in the current study rather than anatomic landmarks for the analysis. WebCeph, an AI - based programme, has been shown to be as accurate and dependable for cephalometric analysis as manual tracing and a well - established digitally conducted cephalometric tracing in the previous literatures. [[6, 11, 18, 19]

The main goal of this study was to compare how WebCeph cephalometric analysis performed on two distinct operating systems. The outcomes showed that WebCeph's measurements of all chosen parameters under both operating systems were highly reliable.

Although various research have found that AI - based digital softwares have good reliability, AI by itself is still not completely dependable at locating the various landmarks on lateral cephalometric radiographs. [20, 21] A reliable technique in lateral cephalometric analysis was discovered to be the AI of WebCeph followed by manual adjustment of the landmark positions. [20] Due to potential interferences with the algorithm for landmark identification, AI - based digital softwares require high resolution lateral cephalograms and the lack of superimposed structures. [22] This drawback is not present in manual tracing because the operator can discriminate and assess the structures based on sound knowledge and judgment. [6]

5. Conclusion

Based on the findings of this study, it can be concluded that even when performed on two different operating systems, the linear and angular measurements obtained from the WebCephTM cephalometric analysis programme do not differ significantly. Despite being an effective and quick tool, orthodontists continue to serve an essential role in integrating diagnostic records so as to determine a conclusive and accurate diagnosis.

6. Limitations and Future Suggestions

As the reliability and accuracy of AI digitising and measurements have been examined in several studies, this study was carried out to see if the cephalometric values obtained using the Webceph app, when done on two distinct operating systems, were comparable with each other. Also this was a short study based on a small sample size, so the current findings should be interpreted cautiously until further research with larger samples can validate them. Another drawback is that only a single cephalometric analysis (Steiners) was used to base the data, and cephalograms were derived from one specific specialized radiography lab, which restricts the implications of the findings to other conditions. To strengthen the theoretical basis of the study, future research should increase the range of observations and incorporate multiple software programmes and cephalometric studies.

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