Original Article

Smartphone-based Cephalometric Tracing App versus Computerized Cephalometric Tracing Program for Orthodontic Cephalometric Analysis: How Reliable?

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Abstract

Objective: This study aimed to assess the reliability of the android smartphone-based app One Ceph by comparing it with the computer cephalometric tracing program FACAD Imaging software. **Methods:** A Total of 35 cephalometric radiographs were randomly selected. 12 parameters indicating skeletal, dental, and soft tissue parameters were selected and measured. The values obtained from FACAD imaging software, and the One Ceph app were compared concerning the assessment of measurements of various parameters by one-way analysis of variance. **Results:** All measurements for each method showed a strong correlation, and it was observed that there were no significant differences between FACAD imaging software and One Ceph app ($P < 0.05$) in all skeletal, dental, and soft-tissue measurements. **Conclusion:** This study showed that the tracing with the One Ceph software had the same accuracy as FACAD software. Therefore, it can be concluded that this app is reliable, user-friendly which facilitates its use by the clinician on a regular basis.

Keywords: One ceph, FACAD, Cephalometrics.

Introduction

Cephalometrics plays a pivotal role in the diagnosis and treatment planning of orthodontic problems. Cephalometry was invented by Broadbent in 1931; since then, it is given a greater importance in the diagnosis and treatment of various malocclusions and underlying skeletal discrepancies, and also for the study of the growth and development of various craniofacial structures and teeth.[1]

The manual cephalometric analysis is usually carried out on acetate tracing sheets, where landmarks are located and then linear and angular parameters are measured. In spite of its extensive application in the field of orthodontics, it is prone to systematic and random error and is also time-consuming.[2]

The major sources of error in the cephalometric analysis include radiographic film magnification, tracing, measuring, recording, and landmarks identification. Of all these, landmark identification being the major source of errors, and this depends on the experience of the operator, density and sharpness of the image. With the increase in advancement of computer radiography, digital method gradually replaced the manual method. Incidence of individual error can be minimized using computers in treatment planning.[3] In computerized cephalometric analysis, once the requested landmarks have been entered, the software automatically calculates linear and angular measurements, so that errors that may occur in hand tracing when drawing lines with a ruler and measuring angles with a protractor can be eliminated. It provides rapid, accurate and standardized evaluation with a high rate of reproducibility. Therefore, it is crucial to keep the method error to a minimum to see the valid small changes that are achieved by treatment.

The reliability and reproducibility of the measurements with the FACAD and with the conventional method are highly correlated. There are many advantages with the digital imaging such as enhancement, transmission, archiving, and low radiation dosages. These advantages make the digitized

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method to be better used over conventional method in regular use without the loss of quality according to Farooq *et al*.[4]

FACAD is a software program that is used in orthodontics for tracing in cephalometric analysis and visual diagnostic imaging as well as for the treatment planning with soft tissue profile prediction for both orthodontics and maxillofacial surgery. This software was developed by the Swedish company Ilexis AB, located in Linkoping, Sweden.

Recently, there has been a rapid increase in the usage of latest technology in all aspects of our lives. Not only has there been a rise in the use of smartphone apps, but also there are apps that have been designed for the medical and dental field. These mobile apps have been one of the fastest developing programs, and they consists of various programs which are designed particularly for orthodontics. When desktop computer access is not feasible and quick reference is required, these android based apps are idea tools because of their speed, ability to update, and portability, according to Goracci and Ferrari.[5]

Because of user friendliness this OneCeph app can be utilized with great accuracy for the cephalometric analysis of most of the measurements required in day-to-day clinical orthodontic practice by Shettigar *et al*.[6]

Khader *et al*.[7] provided evidence that there is no statistically significant difference between the values obtained for Tweed analysis by hand tracing and android-based "OneCeph" tracing, since the tracing with the OneCeph software had the same accuracy with the manual tracing; it can be used instead of the conventional methods.

With the rise of computer-based cephalometric tracing programs usage in regular orthodontic practice, there is a need to evaluate the accuracy of these cephalometric tracing software to allow the clinician to decide the suitable software and types of analysis.

The study was aimed to evaluate the reliability of the android mobile-based app OneCeph by comparing it with the computer cephalometric tracing program FACAD Imaging software.

Methodology

Source of the study

Thirty-five lateral cephalograms were taken randomly from patients who had consulted the Department of Orthodontics and Dentofacial Orthopedics of Vishnu Dental College, Bhimavaram.

Inclusion criteria

Good-quality radiographs permit the identification of landmarks and the radiographs taken from the same machine.

Exclusion criteria

- Poor-quality radiographs
- Radiographs of patients with craniofacial deformities
- Radiographs of patients with missing teeth.

Digital lateral cephalometric radiographs were collected from the Department Of Orthodontics and Dentofacial Orthopedics at Vishnu Dental College and Hospital, Bhimavaram. After obtaining the soft copy of the lateral cephalogram, the digital images (35 cephalograms) were imported into FACAD (Figure 1) software and the digital tracing was done. Landmark identification was carried out on digital images manually using a mouse-driven cursor followed by storing them in the FACAD Imaging archive.

Similarly, OneCeph (Figure 2) digital cephalometric tracer was downloaded from Google Play Store in the android phone, digital radiographs are transferred to the OneCeph app (version beta 1.1) and calibrated, and digital tracing is done. 12 parameters indicating skeletal, dental, and soft tissue parameters were selected and measured (Table 1).

Intraobserver reliability

All the landmarks were identified and marked digitally on the software by a single observer to avoid inter-examiner bias.

To determine intraoperator error and the reproducibility for the digital methods, 10% of the radiographs were retraced by the same operator after a 3 weeks interval. The same scanned image was evaluated on both occasions to avoid scanning and orientation on the Frankfort horizontal that would interfere with the reliability and reproducibility calculations of the cephalometric measurements.

Statistical analysis

All the data were analyzed with the statistical package for social sciences version 13.0. To evaluate the reliability of the various modalities, coefficients of variation were computed for all the parameters, by analysis and imaging modality. To find out whether the values reported by the imaging modalities differed, the means of all the modalities for one subject were subjected to a one-way analysis of variance, keeping $P < 0.05$ as significant. To measure standardized covariance of the duplicate measurements, intraoperator error was determined using Pearson's correlation test

Results

It is observed that all the parameters including skeletal, dental and soft tissue showed no significant differences between FACAD and OneCeph ($P > 0.05$) (Table 2). A significant and strong correlation was obtained between the measures from the FACAD and OneCeph app for each parameter.

Discussion

Lateral cephalogram plays an important role in Orthodontic diagnosis and treatment planning, cephalometric tracing done by hand previously is being gradually replaced by the digital cephalometric tracing programs in this technological era. latest technological advancements have led to the increase in the use of digital cephalometric analysis systems, which have many advantages such as low radiation, improved data storage, and

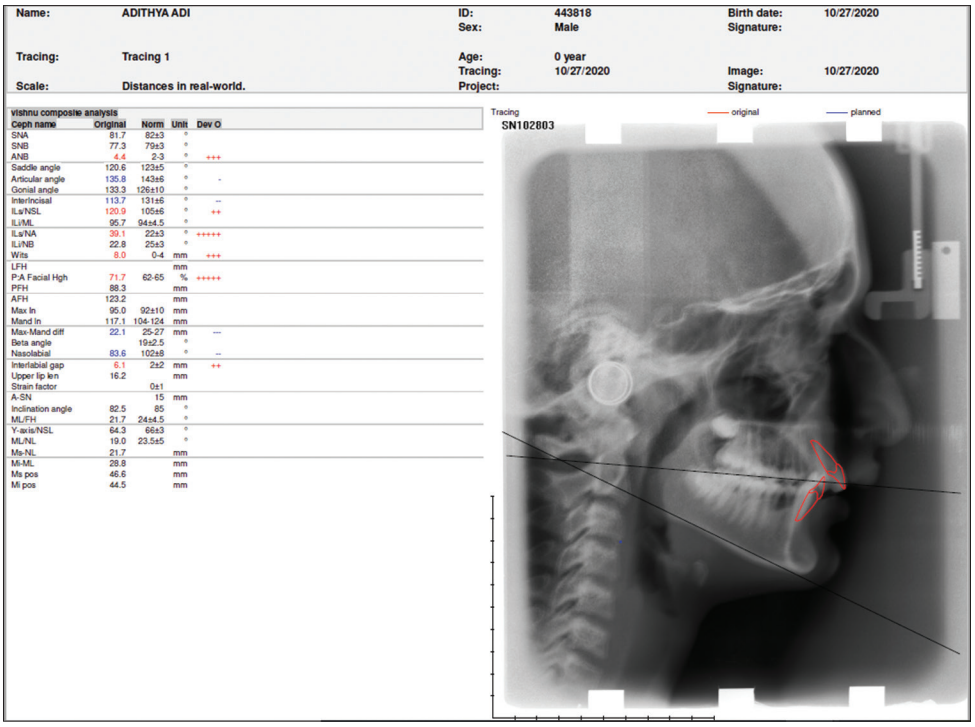

Figure 1: FACAD

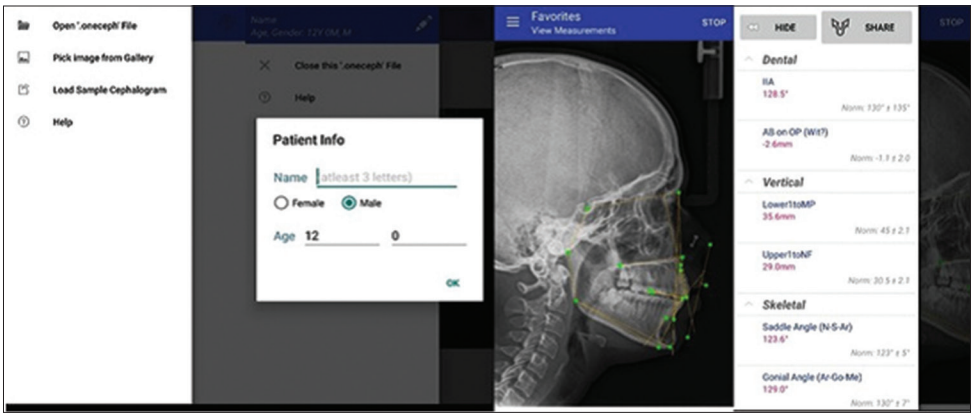

Figure 2: One Ceph

images are easily traced irrespective of whether the technique we choose is digital or a smartphone app; it is essential that it should be reliable, safe, accurate, precise, and have a greater rate of reproducibility.

One of the main cause of tracing error is unpredictibilty in landmark identification, where skill is required dependent on an examiner's experience. It has been showed that trained and untrained operators has significant difference in landmark identification. In addition to that, it is well known that adequate knowledge in digital cephalometrics improves reliability and also decreases errors.

Farooq *et al*.[4] compared the accuracy and reliability of cephalometric measurements between the computerized tracing method and conventional tracing of 50 patients. Results showed that most of the measurements were reliable except for some measurements between the computerised tracing with FACAD® and conventional manual methods. The advantages of digital imaging which include enhancement, archiving, transmission, and low radiation dosages makes the FACAD software more preferred over conventional methods in daily use. Hence in this study, FACAD software was used because of its advantages and found not much of significant difference with the conventional.

Recently, there has been a increase in the use of smartphone apps, In the present study, OneCeph cephalometric app was used. This android based OneCeph app consists of programs for the most commonly used analyses in cephalometrics which include Downs, Holdway, Jarabak, McNamara, Ricketts, Steiners, Schwarz, Tweed, Wits Appraisal, Beta angle, and Yen angle. The capability of a smartphone to simplify a difficult and time-consuming diagnostic task such as cephalometric

Table 1: Cephamoletric parameters

S. No	Parameter	Measurement
1	SNA	Angle formed between Sella-Nasion and Nasion-point A
2	SNB	Angle formed between Sella-Nasion and Nasion-point B
3	ANB	The angle formed between Nasion- point A and Nasion-point B
4	LAFH	Distance between ANS and menton
5	U1 to NA	Angle and linear measurement between the long axis of upper incisor and NA line
6	L1 to NA	Angle and linear measurement between the long axis of lower incisor and NA line
7	IMPA	The angle between the long axis of the lower incisor and mandibular plane
8	E LINE	A line is drawn from pronasale to soft tissue pogonion

analysis, while simultaneously providing the structured reference and e-learning capabilities is a hallmark of this app.

Similarly, Shettigar *et al*.[6] Conducted a study to evaluate the reliability of the android mobile-based One Ceph app by comparing it with the computerized cephalometric tracing program Dolphin Imaging software, and results have shown that SNB, FMA, Basal Plane Angle, L1 to MP showed a significant difference between a dolphin and One Ceph which were not in accordance with our study.

A study done by Livas *et al*.[8] provided a detailed analytical assessment of the validity and reliability of linear and angular cephalometric measurements obtained by CephNinja and OneCeph apps. Overall, both the apps performed satisfactorily, which suggests the potential use of easy-to-reach digital technology makes cephalometrics more readily accessible. By visualising the number of app measurements below the acceptable cutoffs for research and clinical practice, OneCeph can be considered a slightly more valid alternative to Viewbox than CephNinja.

In view of the above studies, the present study was done to compare the FACAD and OneCeph software. A total of thirty-two lateral cephalograms from departmental archives were taken digitally and traced by two different techniques each time, the semi-automatic digital method using FACAD software in computer associated with cephalometric imaging machine and fully digital automatic tracing using dedicated "OneCeph. The sample size was calculated by considering the test power of 0.80. The 12 cephalometric parameters that is seven angular and five linear were taken for the study because they were frequently used, easy to locate and have a high degree of agreement among observers.

Of all the parameters, five were skeletal, three were dental, and two were soft tissue parameters, and all the parameters showed no statistically significant difference between the groups (Table 2) which were in accordance with the study conducted by Khader *et al*.,[7] it can be said that the OneCeph

Table 2: Comparison of results of the tests between One ceph and digital (Facad) tracings

Group	*n*	Mean	Std. Deviation	Std. Error Mean	*P*-value
SNA					
One ceph	35	80.32	4.10	0.69	0.594
Facad	35	80.83	3.83	0.65	NS
SNB					
One ceph	35	76.23	4.12	0.70	0.530
Facad	35	76.85	3.99	0.67	NS
ANB					
One ceph	35	3.93	3.05	0.52	0.981
Facad	35	3.95	3.04	0.51	NS
LAFH					
One ceph	35	67.16	8.57	1.45	0.289
Facad	35	69.41	8.97	1.52	NS
BETA(°)					
One ceph	35	27.35	6.50	1.10	0.556
Facad	35	28.27	6.44	1.09	NS
UI-NA (MM)					
One ceph	35	6.09	3.07	0.52	0.367
Facad	35	6.71	2.65	0.45	NS
UI-NA(°)					
One ceph	35	35.49	8.49	1.44	0.706
Facad	35	36.25	8.27	1.40	NS
LI-NB (mm)					
One ceph	35	5.67	2.37	0.40	0.894
Facad	35	5.59	2.62	0.44	NS
LI-NB(°)					
One ceph	35	33.48	7.70	1.30	0.770
Facad	35	34.03	7.95	1.34	NS
IMPA					
One ceph	35	102.68	7.72	1.30	0.506
Facad	35	103.93	7.86	1.33	NS
E LINE (U)					
One ceph	35	0.01	2.59	0.44	0.482
Facad	35	0.47	2.85	0.48	NS
E LINE (L)					
One ceph	35	1.69	3.56	0.60	0.722
Facad	35	1.99	3.39	0.57	NS
AIRWAY (U)					
One ceph	35	14.51	2.46	0.42	0.388
Facad	35	13.98	2.58	0.44	NS
AIRWAY (L)					
One ceph	35	10.35	1.92	0.32	0.990
Facad	35	10.35	1.70	0.29	NS

app is as reliable as the FACAD cephalometric method and that the minimal changes can be due to the changes in the operator's reproducibility of the landmarks and calibration of the cephalometric image in the app.

These software programs can be either automated or semiautomated. This study used semiautomated software. First, the manual location of landmarks is done, and then the cephalometric analysis was performed by the computer. This leads to reduced measurement errors than the conventional cephalometric analysis. The unpredictability in landmark identification causes significant

tracing errors, which requires skills that depend on the operator's experience quality of original radiographs, resolution of the digital images, nature of the cephalometric landmark.

A study done by Erkan and his associates had showed the importance of standardization in comparative studies like this study. The intra-examiner error is lesser than the inter-examiner error; thus, to reduce the number of errors, this study was standardized for both FACAD digital tracing method and the OneCeph app cephalometric method by having only one examiner and the present study was done to evaluate the comparative accuracy of semi-digital and fully digital cephalometric tracing methods in orthodontics as the fully digital method has been reported advantageous of being time-saving, improved contrast and reduced inter-and intra-observer variability, Intraoperator error (reliability) of angular and linear measurements were assessed and showed a high correlation between repeated measurements of the conventional and the digital tracings, indicating that the investigator had no difficulty in correctly repeating measurements and the landmarks were easily identifiable.

An android based OneCeph app provides a convenient interface with the most commonly used analyses. This app also demonstrates the capability of a smartphone to simplify a difficult, time-consuming diagnostic task such as cephalometric analysis while simultaneously providing structured reference and e-learning capabilities and can be utilized with sufficient accuracy and when portability is prioritized.

Conclusion

The following conclusions are drawn

1. In this study, a total of twelve cephalometric parameters were measured with OneCeph and FACAD software
2. A comparison of both methods showed no statistically significant differences in any of the parameters
3. Therefore, it can be concluded that this app is reliable, user-friendly which facilitates its use by the clinician on a regular basis, and can be utilized with sufficient accuracy and when portability is prioritized for the cephalometric analysis of most of the measurements required in day-to-day clinical orthodontic practice.

References

1. Gregston MD, Kula T, Hardman P, Glaros A, Kula K. A comparison of conventional and digital radiographic methods and cephalometric analysis software: I. Hard tissue. Semin Orthod 2004;10:204-11.
2. Kublashvili T, Kula K, Glaros A, Hardman P, Kula T. A comparison of conventional and digital radiographic methods and cephalometric analysis software: II. Soft tissue. Semin Orthod 2004;10:212-9.
3. Naoumova J, Lindman R. A comparison of manual traced images and corresponding scanned radiographs digitally traced. Eur J Orthod 2009;31:247-53.
4. Farooq MU, Khan MA, Imran S, Sameera A, Qureshi A, Ahmed SA, *et al*. Assessing the reliability of digitalized cephalometric analysis in comparison with manual cephalometric analysis. J Clin Diagn Res 2016;10:ZC20-3.
5. Goracci C, Ferrari M. Reproducibility of measurements in tablet-assisted, PC-aided, and manual cephalometric analysis. Angle Orthod 2014;84:437-42.
6. Shettigar P, Shetty S, Naik RD, Basavaraddi SM, Patil AK. A Comparative evaluation of reliability of an android-based app and computerized cephalometric tracing program for orthodontic cephalometric analysis. Biomed Pharmacol J 2019;12:341-6.
7. Khader DA, Peedikayil FC, Chandru TP, Kottayi S, Namboothiri D. Reliability of one ceph software in cephalometric tracing: A comparative study. SRM J Res Dent Sci 2020;11:35.
8. Livas C, Delli K, Spijkervet FK, Vissink A, Dijkstra PU. Concurrent validity and reliability of cephalometric analysis using smartphone apps and computer software. Angle Orthod 2019;89:889-96.