RESEARCH ARTICLE

Assessment of the reliability of digital cephalometric analysis using One Ceph app in comparison with manual cephalometric analysis

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Abstract

Objective: To evaluate and compare the accuracy and reliability of digital cephalometric tracing against the traditional manual tracing method.

Method: The retrospective, cross-sectional study was conducted at the Department of Orthodontics, Foundation University College of Dentistry and Hospital, Islamabad, Pakistan, from January to April 2024, and comprised randomly-selected, good-quality pre-treatment lateral cephalometric radiographs taken from the same imaging machine. The radiographs were subjected to both manual and digital OneCeph tracing methods by a single operator. Ten cephalometric variables used in Steiner's analysis were assessed. Data was analysed using SPSS 21.

Results: Of the 60 radiographs range assessed, 30(50%) were included; 18(60%) from female patients and 12(40%) from male patients. The patient age was 15-40 years. When subjected to both manual and digital tracing, the radiographs showed no significant difference in any of the 10 parameters assessed between the two methods (p>0.05).

Conclusion: Digital tracing of lateral cephalometric radiographs could be a reliable alternative to manual tracing.

Keywords: App, Cephalometrics, Analysis, Reliability, Cross-sectional study. (JPMA 76: 187; 2026)

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Introduction

Lateral cephalometric analysis has long been used in orthodontics and dentofacial orthopaedics as a diagnostic tool. It continues to be one of the gold standards when it comes to identifying patients underlying skeletal and dental discrepancies.[1] In the field of orthodontics, manual tracing is rapidly being replaced by digital tracing, showing a significant shift in the industry.[2] Advances in technology have driven a shift towards digital orthodontics, increasing the speed, quality, and reliability of treatments.[3,4] The advent of software and applications (apps) has significantly increased opportunities for orthodontists to incorporate these technological advancements into their clinical practice.[5]

Cephalometric tracing is done manually, which is time-consuming and needs an extensive armamentarium. Even then, manual tracing is still a common method of tracing. In contrast, computer-based software is reliable, needs no armamentarium, is quick to perform, and provides efficient record-keeping.[6] However, a significant drawback of computer-based software is its initial high cost, and most of the clinicians in developing and underdeveloped countries may not be able to afford such costly software.[7]

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Mobile phones, on the other hand, are devices accessible to almost everyone, and can be put to efficient use in the field of orthodontics for cephalometric analysis. One mobile phone app for this purpose is OneCeph, which is freely available on the Android PlayStore for download.[8,9]

Previous research into the comparison of manual tracing versus digital tracing using mobile applications has produced conflicting findings, highlighting the need for further investigation. A common factor in studies with significant results was the identification of point A, which can be marked incorrectly due to human error. These errors may have contributed to the significant results observed in those studies.[1]

The current study was planned to compare the accuracy and reliability of cephalometric analysis using OneCeph app in contrast to the manual tracing method while ensuring the accurate identification of all points, specifically point A.

Materials and Methods

The retrospective, cross-sectional study was conducted at the Department of Orthodontics, Foundation University College of Dentistry and Hospital, Islamabad, Pakistan, from January to April 2024, and comprised randomly-selected 60, good-quality pre-treatment lateral cephalometric radiographs taken from the same imaging machine. Radiographs of patients with missing incisors or with any craniofacial anomalies were excluded. Approval was obtained from the institutional ethics review committee, and informed consent had been obtained from all the patients at the time of treatment. The radiographs were obtained through electronic medical records using non-probability consecutive sampling technique. Steiner's analysis was explicitly used as the primary approach for measurement and evaluation as it is the most commonly used analysis in treatment planning, and includes both skeletal and dental parameters.[10] The variables measured and analysed included eight angular and two linear measurements. They were Sella-Nasion-A Point Angle (SNA), Sella-Nasion-B Point Angle (SNB), A Point-Nasion-B Point Angle (ANB), Sella-Nasion-Occlusal Plane Angle (SNOP), Sella-Nasion-Mandibular Plane Angle (SNMP), (Upper Incisor to Nasion Angle (UINA), Lower Incisor to Nasion Angle (LINB), Inter-Incisal Angle (IIA), Upper Incisor to Nasion Distance (UINA), and Lower Incisor to Nasion Distance (LINB).

The radiographs were randomly selected using the online tool random.org.[7] This was done to reduce selection bias. The sample size was based on previous studies.[7]

Any radiographic error was corrected that could potentially introduce bias into the results. On the selected radiographs, both digital (D) and manual tracings were performed. For digital cephalometric tracing, the OneCeph app was downloaded from the Google PlayStore on an Android phone. To see the parameters and examine the cephalograms, a smartphone with a 6.44-inch AMOLED (Active-Matrix Organic Light-Emitting Diode) display and a resolution of 1,080x2,400 pixels was employed. Digital radiographs were imported in JPG (Joint Photographic Experts Group) format. Additionally, the operator used software tools, like brightness and magnifications, if necessary, to increase the accuracy of the landmarks. The starting and end points of each radiograph were marked to calibrate the images. Landmark identification was done on the touch screen by the use of a finger to represent mainstream use as most smartphones are not equipped

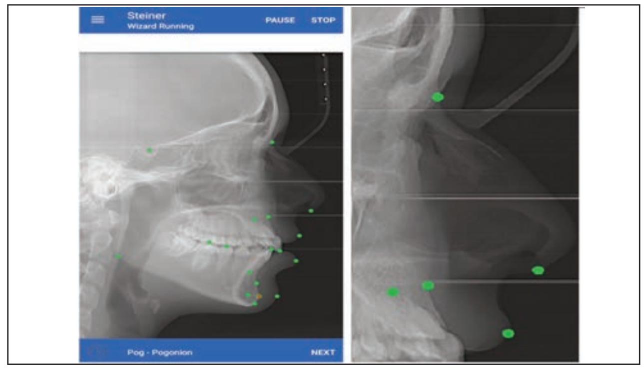

Figure-1: Landmarks identified on OneCeph app. A: An overall view. B: Zoomed-in view.

with a stylus (Figure 1). The software performed the analysis and the obtained data was downloaded in a PDF (Portable Document Format) file.

For manual cephalometric analysis, the films were placed on an illuminator following standard procedures ensuring accurate landmark identification. An acetate tracing sheet was carefully attached to the film to perform manual tracing. The tracing procedure was carried out in a controlled dark room setting to ensure the best visibility and the removal of any potential interference sources. A 0.3mm-tip lead pencil was used to mark the landmarks and both linear and angular measurements were accurately recorded. Past research has emphasised the importance of precise landmark identification for avoiding errors inherent in traditional cephalometry.[1]

Both manual and digital cephalometric assessments were carried out by a single operator with a gap of two weeks between the two methods to reduce potential bias and errors. The difference in digital and manual cephalometric analysis of one of the patients is shown in figure 2.

Data was analysed using SPSS 21. The normality of continuous data was assessed using Shapiro-Wilk test. For variables with normal distribution, independent sample t-

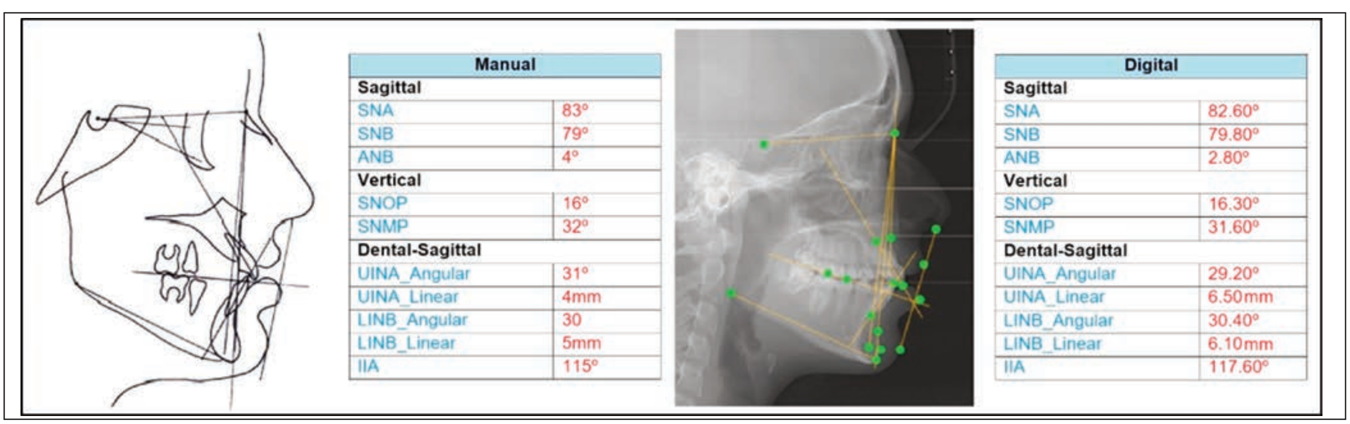

Figure-2: Difference in angular and linear measurements of the same patient on manual and digital cephalometric analysis.

Table-1: Comparison of cephalometric variable measurements using OneCeph Digital tracing (D) and Manual tracing (M).

Variables (n=30)	**Group**	**Mean±SD**	**Std. Error**	***p*-value**
SNA	D	82.58 ± 4.21	0.76985	0.735
	M	82.23 ± 3.72	0.68091	
SNB	D	78.24 ± 4.48	0.81798	0.848
	M	78.03± 4.11	0.75122	
ANB	D	4.34 ±2.52	0.46035	0.910
	M	4.26± 2.70	0.49348	
SNOP	D	19.22 ±5.35	0.97816	0.112
	M	17.20± 4.30	0.78550	
SNMP	D	30.17 ±6.58	1.20160	0.924
	M	30.33± 6.08	1.11142	
UINA Angular* **	D	27.37± 10.96	2.00148	0.652
	M	27.53± 8.73	1.59506	
UINA Linear	D	6.04 ±3.73	0.68166	0.442
	M	5.40 ±2.60	0.47610	
LINB Angular	D	29.30± 8.36	1.52808	0.803
	M	29.80± 6.98	1.27523	
LINB Linear* **	D	6.94 ±3.37	0.61569	0.113
	M	5.60 ±2.41	0.44100	
IIA* **	D	117.96± 13.30	2.42836	0.695
	M	119.06 ±12.16	2.22159	

*:$p \leq 0.05$; ***L: These variables are not normal; SNA: Sella-Nasion-A Point Angle, SNB: Sella-Nasion-B Point Angle, ANB: A Point-Nasion-B Point Angle, SNOP: Sella-Nasion-Occlusal Plane Angle, SNMP: Sella-Nasion-Mandibular Plane Angle, UINA: Upper Incisor to Nasion Angle, LINB: Lower Incisor to Nasion Angle, IIA: Inter-Incisal Angle, UINA: Upper Incisor to Nasion Distance, LINB: Lower Incisor to Nasion Distance.

test was used, while for variables with non-normal distribution, Mann-Whitney U test. An independent sample t-test was used to compare the mean values of the measured variables between manual and digital tracing. The significance level was set with 95% confidence interval (CI). P<0.05 was considered statistically significant.

Results

Of the 60 radiographs assessed, 30(50%) were included; 18(60%) from female patients range and 12(40%) from male patients. The patient age was 15-40 years. When subjected to both manual and digital tracing, the radiographs showed no significant difference on any of the 10 parameters assessed between the two methods ($p>0.05$) (Table-1).

Discussion

In the current study, accuracy and reliability of digital cephalometric analysis were compared with manual tracing. Both the tracings were done by the same examiner with a two-week gap between them to remove any inter-examiner and intra-examiner bias. The results showed that OneCeph app was comparable to manual tracing.

The current results are in line with previous studies.[1,2] A recent study by Chug et al. found that the OneCeph app demonstrated good to excellent reliability for 14 linear and angular measurements, comparable to traditional computer software (Dolphin imaging software). OneCeph app displayed good to excellent inter-observer and intra-observer reliability for cephalometric measurements, comparable to traditional software. While no significant differences in accuracy were observed, the app required slightly more time for analysis.[11]

While these findings are in line with those of the current study, Kılınç et al. reported a different outcome, suggesting statistically significant differences for various parameters using an app other than OneCeph.[12]

Literature on the use of mobile software for cephalometric assessments presents a mixed picture. A recent study by Goyal et al investigated the accuracy of the OneCeph application in measuring various parameters, like gonial angle, lower anterior facial height (LAFH), anterior maxillary and mandibular dental heights on lateral cephalograms and OPG (Orthopantomogram). The results indicated that anterior maxillary and mandibular dental height increased with an increase in gonial angle and lower anterior facial height on lateral cephalograms. However, there were discrepancies between the measurements obtained on OPG and lateral cephalograms. These differences in vertical linear measurements could be attributed to different growth patterns and positioning errors on the OPGs. The study concluded that OneCeph app enabled reliable gonial angle measurement and maxillary anterior dental height on an OPG.[13]

Compatibility of OneCeph app with use on personal computers (PCs), tablets and smartphones has been studied by Kanpittaya P. Among 24 cephalometric measurements selected, 21 variables measured on OneCeph mobile and tablet, and 20 variables on PC were on a par with those done on Dolphin software.[14]

Traditional manual cephalometric analysis is time-consuming and is subject to human errors.[15-17] On the other hand, software technology is capable of eliminating these errors. It functions in two ways; one being fully automated, where processes are entirely driven by algorithms, and the other being semi-automated, where human intervention is still required to some extent alongside automated functions.[18] OneCeph functions as a semi-automation app; first manual identification of the landmarks is done by the operator and then targetted cephalometric analysis is performed by the app. A study concluded that this approach led to fewer errors than conventional manual tracing.[19]

The current study reinforced the role of mobile technology in the field of orthodontics. However, the current study has limitations, including a small sample size, subjective identification of landmarks, and possible errors due to image quality and resolution. While every effort was made to obtain the highest-quality images possible, it is important to acknowledge that at times it may be challenging to entirely eliminate artefacts that can affect the precision of cephalometric analysis. Future studies should include larger sample sizes, objective methods for landmark identification, and standardised image acquisition and processing techniques. To further advance the understanding of the comparative effectiveness of digital cephalometric analysis and manual tracing, the prospect of longitudinal studies should be contemplated. Such longitudinal studies could offer insights into the long-term implications of the chosen cephalometric method.

Conclusion

Digital tracing of lateral cephalometric radiographs could be a reliable alternative to manual tracing.

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Conflict of Interest: None.

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Author Contribution:
MK: Design, data analysis, interpretation, drafting, proper investigation and resolution of questions.
RN: Design, data analysis, interpretation, drafting, revision and final approval.
RA: Drafting, revision, proper investigation and resolution of questions.