ORIGINAL RESEARCH

Comparative Evaluation of Nemoceph and Foxit PDF Reader for Steiner's Cephalometric Analysis

MukeshKumar[1], Sommya Kumari[2], Veena Ranjeet Kumar[3], Dhirendra Pratap Singh[4], Ravi Ranjan[5], Ashish Kumar[6]

Abstract

Aim: The aim of this study was to evaluate and compare the values of Steiner s cephalometric analysis using Nemoceph and Foxit PDF Reader. No signi cant di erence between the two methods will result in that Foxit PDF Reader can be used as a cost-e ective alternative.

Materials and methods: This study was conducted on 100 digital lateral cephalograms taken from the same machine. The samples were collected by nonprobability convenience sampling procedures. These images were analyzed for Steiner s cephalometric analysis using two software packages.

Results: The skeletal and dental values showed no statistically signi cant di erence in the majority, except for the L1-NA (linear) and L1-NB (linear).

Conclusion: Results showed that there is a high agreement between the two methods.

Clinical signi cance: This article provides a simple and cost-e ective method of onscreen cephalometric analysis. This technique uses the inbuilt measurement tools in the tool bar of our daily use software. The method can be used independently anywhere without any internet connection and software subscription.

Keywords: Cephalometry, Digital imaging, Onscreen tracing.

The Journal of Contemporary Dental Practice (2019): 10.5005/jp-journals-10024-2645

Introducton

Harmonious facial esthetics and optimal functional occlusion with a rm structural balance is a recognized canon for orthodontists.[1,2] A scienti c approach to analyze the human craniofacial patterns was pioneered by anthropologists and anatomists.[3-5] Since the introduction of cephalometric radiography by Broadbent in 1931, signi cant advancement has been achieved over the years.[4,6,7] The vital role of cephalometric analysis in orthodontic diagnosis, treatment planning, and monitoring treatment and growth changes is well established.[7-9]

The traditional hand-tracing process of cephalometric analysis uses an acetate overlays, pencil, ruler, and protractor to measure the linear and angular values. Though most economical and accessible, the potential systematic and random error, high time demand, special dark chamber, chemical hazard, together with di cult archiving are among the possible cause of its set back.[10,11]

Digital radiographic technique emerged during the late 1980s and early 1990s brought the cephalometric radiographs on screen. These digital cephalometric images created a surge for computer cephalometric analysis software.[12] Many cephalometric analysis programs were developed since then claiming themselves better than the best. This technological advancement not only overcome the limitations of the manual cephalometric technique but also enabled brightness and contrast control facility for easy landmark identi cation, leading to accuracy.[13-16]

The availability, affordability, and user-friendly score of this commercially available software remained questionable.[17] Therefore, the present study was conducted with an objective to compare the mean values obtained by evaluating digital lateral cephalograms using Nemoceph cephalometric analysis software (Nemoceph NX 2009 for Windows) and the general measurement tools available in the toolbar of Foxit PDF Reader (Foxit PDF Reader, version 3.0) for Steiner s cephalometric analysis.

[1]Department of Orthodontics, Paci c Academy of Higher Education and Research, Udaipur, Rajasthan, India

[2]Department of Prosthodontics, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India

[3,6]Department of Orthodontics, Paci c Dental College, Udaipur, Rajasthan, India

[4]DJ College of Dental Sciences and Research, Modinagar, Uttar Pradesh, India

[5]Department of Orthodontics, Chandra Dental College and Hospital, Barabanki, Uttar Pradesh, India

Corresponding Author: Sommya Kumari, Department of Prosthodontics, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India, Phone: +91 8969859326, e-mail: sommyakumari@gmail.com

How to cite this article: Kumar M, Kumari S, *et al*. Comparative Evaluation of Nemoceph and Foxit PDF Reader for Steiner s Cephalometric Analysis. J Contemp Dent Pract 2019;20(9):1051 1055.

Source of support: Nil

Conf ict of interest: None

Materials and Methods

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics at Paci c Dental College, Udaipur, Rajasthan. One hundred digital lateral cephalograms of the prospective orthodontic patients reporting to the OPD of the Orthodontic Department were included in the study. The study was approved by the institutional research committee and is recognized by the scholar s enrollment number. Since this study used diagnostic images of prospective orthodontic patients, and no subject was radiated without an indication. Therefore, speci c ethical committee

' *The Author(s). 2019 Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.*

clearance was not required. This study compared the mean values of the samples studied, and no patient-speci c data was disclosed. Therefore, informed consent of the patient was not necessary.

All the radiographs were taken from the same digital OPG machine with an automatic KVp and mA setting. All the radiographs were taken by the same radiographic technician, adhering to the radiation hygiene protocol. The samples were selected through non-probability convenience sampling procedures. All the radiographs were selected based on the quality and clarity of images and with ease for identi cation of landmarks. The selection criteria were not to be a ected by age, gender, machine, head positioning, and tooth contact. Poor quality image, distortion, artifact, and craniofacial anomalies were excluded from the study. Angle s system of classi cation did not a ect the selection criteria.

A laptop with a mouse-controlled cursor was used for onscreen landmark identi cation and cephalometric analysis. The following landmarks were identi ed: sella, nasion, point-A, point-B, gnathion, gonion, upper incisor incisal edge, upper incisor root apex, lower incisor incisal edge, lower incisor root apex, upper rst molar cusp tip, and lower rst molar cusp tip. The landmark identi cation was done for all the radiographs using both the software:

Nemoceph NX 2009 for Windows (commercially available) and Foxit PDF Reader, version 3.0 (free download software)

Image magni cation and contrast enhancement tools were used for easy identi cation of landmarks in both the software evaluated. All the cephalograms were evaluated by the same operator using both the software. Only 05 (ve) cephalograms were evaluated using either of the software in each session to minimize error. The interval between the sessions was maintained to be 24 hours to prevent operator fatigue.

The lateral cephalometric radiographs were cropped to the size of standard lateral head lm (8 × 10 inches) using Adobe Photoshop. A ruler scale image of 8 inches was added on the top of this image, extending from the right margin to the left margin for easy calibration with the software to be tested. The standardized and calibrated images were numbered 1 100 on the upper right-hand side corner of the images for identi cation. The images were saved in JPEG and PDF format, with a maximum quality setting at 200 dpi, for evaluation with Nemoceph and Foxit PDF Reader software, respectively.

The cephalometric images (in JPEG format) were rst evaluated using Nemoceph NX 2009 software for Windows (Nemotec, Madrid, and Spain). The landmarks were marked as per the software demand and as shown in the lower right corner of the screen. After the completion of landmark identi cation, the tracing was contoured to the best match with the radiographic image. Further, the cephalometric values for Steiner s analysis were taken from the dropbox of the software (Fig. 1).

The cephalometric images (in PDF format) were then opened using Foxit PDF Reader and Tool Box on the top margin was used for all the purposes. The reference planes were drawn using the Line Tool and adjusted using the mouse cursor if required. Further, the Distance Tool and the Area Tool were used for the linear and the angular measurements, respectively. Immediately the observed values were recorded manually on a paper, as this software is not customized for any speci c purpose, and therefore there is no provision of consolidated data collection (Fig. 2).

The data were subjected to statistical analyses using Statistical Package for Social Sciences Software version 11.0 (SPSS Inc, Chicago, IL). One-way ANOVA was used for comparison between

Fig. 1: Cephalometric analysis measurement using Nemoceph software with measurement values

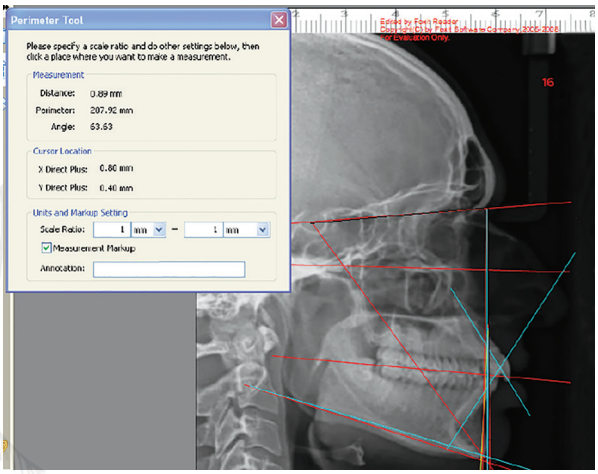

Fig. 2: Cephalometric analysis measurement using Foxit PDF Reader with measurement tools box

the variables and *post hoc* test followed by Turkey s test was done to check the level of signi cance.

RESULT

The one hundred randomly selected, pre-standardized and pre-calibrated digital lateral cephalometric radiographs evaluated for ve skeletal and ve dental values of Steiner s Analysis, using the measurement tools in the toolbar of Foxit PDF Reader and Nemoceph cephalometric software showed the following.

The mean di erence of the skeletal values (SNA, SNB, ANB, mandibular plane angle, and occlusal plane angle) obtained using the two software was comparable clinically (m=0.17 degree to $m$ax= 1.57 degree) and showed no signi cant statistical di erence for the variables using One-way ANOVA. A further *post hoc* test showed the mean di erence for the occlusal plane angle to be signi cantly di erent from the p value 0.49, but the values were acceptable clinically (Tables 1 and 2) (p *0.5 signi cant).

The mean difference of the dental parameters revealed a comparable and clinically acceptable value for the angular measurements, i.e., U1-NA, L1-NB, and Inter incisal angle. Statistical analysis using One-way ANOVA followed by *post hoc* test showed no statistically signi cant di erence. While the linear measurement

Table 1: Comparison of skeletal values between groups (one way ANOVA) (*p* 0.5 signi cant)

Variable	*Group*	*Mean value*	*SD*	*p value*
SNA	Nemoceph	82.83	4.45	0.79
	Foxit	82.16	4.97	
SNB	Nemoceph	78.00	5.48	0.95
	Foxit	77.83	6.09	
ANB	Nemoceph	5.15	3.15	0.69
	Foxit	5.53	3.93	
Mandibular plane angle	Nemoceph	28.95	7.69	0.80
	Foxit	27.73	9.03	
Occlusal plane angle	Nemoceph	15.85	6.31	0.51
	Foxit	14.28	5.49	

Table 2: Comparison of skeletal values between groups (*post hoc* test) (*p* 0.5 signi cant)

Variable	*Group*	*Group*	*Mean di erence*	*p value*
SNA	Nemoceph	Foxit	0.67	0.80
SNB	Nemoceph	Foxit	0.17	0.99
ANB	Nemoceph	Foxit	0.38	0.87
Mandibular plane angle	Nemoceph	Foxit	1.23	0.78
Occlusal plane angle	Nemoceph	Foxit	1.57	0.49

Table 3: Comparison of dental values between groups (one-way ANOVA) (*p* 0.5 signi cant)

Variable	*Group*	*Mean value*	*SD*	*p value*
U-1 to NA (angle)	Nemoceph	24.98	9.44	0.34
	Foxit	28.23	10.79	
U-1 to NA (linear)	Nemoceph	0.22	0.15	0.0001
	Foxit	6.55	4.21	
L-1 to NB (angle)	Nemoceph	29.83	6.87	0.12
	Foxit	29.85	8.33	
L-1 to NB (linear)	Nemoceph	0.28	0.11	0.0001
	Foxit	7.29	2.85	
Inter incisal angle	Nemoceph	120.29	11.93	0.73
	Foxit	118.59	10.92	

values, i.e., U1-NA and L1-NB showed a high mean di erence of 6.33 mm and 7.02 mm, respectively between the two software values. Statistical analysis using One-way ANOVA followed by *post hoc* test showed a statistically signi cant di erence for these parameters with *p* value 0.0001 (Tables 3 and 4) (0.5 signi cant).

A highly comparable and clinically acceptable mean di erence for the angular measurement values of Steiner s analysis, with no statistically signi cant di erence, proves the measurement tools of Foxit PDF Reader to be reliable and cost-e ective alternative to commercially available Nemoceph software for cephalometric analysis.

Discussion

A precise diagnosis and treatment planning is essential to the success of orthodontic treatment. In 1931, orthodontics ushered in the age of radiographic cephalometry.[18] Since then, the orthodontic domain has achieved a new horizon both in research and clinical science.[19,20] A number of di erent cephalometric analyses and norms are available today.[21,22]

Table 4: Comparison of dental values between groups (*post hoc* test) (*p* 0.5 signi cant)

Variable	*Group*	*Group*	*Mean di erence*	*p value*
U-1 to NA (angle)	Nemoceph	Foxit	3.25	0.33
U-1 to NA (linear)	Nemoceph	Foxit	6.33	0.0001
L-1 to NB (angle)	Nemoceph	Foxit	0.02	1.00
L-1 to NB (linear)	Nemoceph	Foxit	7.02	0.0001
Inter incisal angle	Nemoceph	Foxit	1.70	0.83

Traditional cephalometric radiography and analysis were done manually using a large inventory and was prone to errors. The technique also is laden with weaknesses.[23,24]

With the rapid evolution of digital radiography landmark location and onscreen tracing has become area of interest for researchers. Computer-aided cephalometric analysis on digitized cephalogram substantially reduces the potential errors, eliminates the production of hard copies, and is time-saving as well. Currently, cephalometric analyses for orthodontic diagnosis, treatment planning, and research are often performed on digital images using computer software.[25,26] The high cost and availability account limitations of these software programs.

The innovative techniques of Prawat et al. used sonically generated cephalometric values on a digital image analyzer (Digigraph), Shahidi et al. designed software for localization of cephalometric landmarks, and Nouri et al. developed an a ordable Iranian cephalometric analysis software program. These techniques have proven to be successful and have overcome the high cost of the commercially available software with success. But again the availability of this software for practicing orthodontists remained dubious, and developing a new software program by an orthodontist is impractical.[17,27,28]

Precision and reproducibility in data is an essential requirement.[7] Durao et al. reported a lower level of reproducibility in landmarks identi cation among orthodontists compared to maxillofacial radiologist.[29]

The current study compared the mean di erence of the values obtained using the two software, i.e., Nemoceph and Foxit PDF Reader. The pre-standardized and pre-calibrated digital lateral cephalometric radiographs evaluated for the ve skeletal and ve dental values of Steiner s analysis revealed the result showed no signi cant statistical di erence in majority. This was in consonance with the study reports of Erkan, et al. (Dolphin Imaging, Vistadent, Nemoceph, and Quick Ceph); Goracci and Ferrari (Nemoceph for Windows, SmileCeph for iPad, and manual), Rusa et al. (Planmeca Romexis, Orthalis, and AxCeph); and Correia, (Radiocef Studio and Dolphin Imaging); who reported a high consistency between the di erent software evaluated.[30-32]

The mean di erence of the observed skeletal values (SNA, SNB, ANB, mandibular plane angle, and occlusal plane angle) using the two software in our study ranged from 0.17 degrees to 1.57 degrees, with no statistically signi cant di erence. This was in harmony with the report of Sommer et al. who suggested a di erence of below 2° is clinically acceptable for the mid-face structures.[33]

The dental values in our study showed no statistical signi cant di erence in the majority [L1-NA (angle), L1-NB (angle), and inter incisal angle], except for the linear values of L1-NA and L1-NB. A similar nding for linear values was reported by Celik et al. and Aldrees, using Vistadent software vs Ji y orthodontic evaluation program and Dolphin Imaging, with lower incisor to di erent

27. Prawat JS, Nieberg L, et al. A Comparision Between Radiographically And Sonically Produced Cephalometric Values. Angle Orthod 1995;65(4):271 276.
28. Shahidi S, Oshagh M, et al. Accuracy of Computerized Automatic Identi cation of Cephalometric Landmarks by a Designed Software. Dentomaxillofac Radiol 2013;42:1 8. DOI: 10.1259/dmfr.20110187.
29. Durao APR, Morosolli A, et al. Cephalometric landmark variability among orthodontists and dentomaxillofacial radiologists: a comparative study. Imaging Sci Dent 2015;45:213 220. DOI: 10.5624/isd.2015.45.4.213.
30. Goracci C, Ferrari M. Reproducibility of measurements in Tablet-assisted, PC-Aided, and Manual Cephalometric Analysis. Angle Orthod 2014;84:437 442. DOI: 10.2319/061513-451.1.
31. Rusu OL, Petcu AE, et al. Reliability and Accuracy of Three Di erent Computerized Cephalometric Analysis Software. Rev Med Chir Soc Med Nat Iasi 2015;119(1):248 256.
32. Correia TRGS, Sena LMFD, et al. Cephalometric Analysis: Concordance Between Software. Rev Gaucha Odontol (Porto Alegre) 2017;65(4): 321 325. DOI: 10.1590/1981-86372017000200063275.
33. Celik E, Polat-Ozsoy O, et al. Comparison of Cephalometric Measurements with Digital Versus Conventional Cephalometric Analysis. Eur J Orthod 2009;31:241 246. DOI: 10.1093/ejo/cjn105.
34. Sommer T, Ciesielski R, et al. Precision of Cephalometric Analysis via Fully and Semiautomatic Evaluation of Digital Lateral Cephalographs. Dentomaxillofac Radiol 2009;38:401 406. DOI: 10.1259/dmfr/85543699.
35. Tsorovas G, Karsten ALA. A Comparison of Hand-Tracing and Cephalometric Analysis Computer Programs With and Without Advanced Features Accuracy and Time Demands. Eur J Orthod 2010;32:721 728. DOI: 10.1093/ejo/cjq009.
36. Aldrees AM. Evaluation of Incisors Inclination in Five Cephalometric Analysis Methods. Pak Oral Dent J 2010;30(2):1 8.

JAYPEE