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Research Article

A COMPARATIVE ANALYSIS OF ANGULAR CEPHALOMETRIC MEASUREMENTS USING VISTADENT AND NEMOCEPH DIGITAL SOFTWARE

Fundagül BİLGİÇ ZORTUK[1*], Eyüp Burak KÜÇÜK[1]

[1] Hatay Mustafa Kemal University, Faculty of Dentistry, Department of Orthodontics, Hatay, Türkiye

*Correspondence: fbilgic@mku.edu.tr

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ABSTRACT

Objective: The aim of this investigation was to compare the reliability of two different software programs, Vista Dent and NemoCeph for digital cephalometric tracing when used for angular measurements on 2D digital cephalometric radiographs.

Methods: A total of 300 cephalometric radiographs were chosen for this study. The Vista dent and Nemoceph computerized softwares programs were used to obtain cephalometric measurements from lateral cephalograms. The SNA and SNB angle values obtained by the two methods were evaluated through independent sample T-test and and the Mann-Whitney U Test was done to compare GoGn-SN angle between the two different computerized softwares programs. The Pearson correlation analysis was used to evaluate the consistency between the two measurement method.

Results: It shows no statistical difference between the values of the SNA, SNB, and GoGn-SN angles performed by the Vista dent and Nemoceph software ($p > 0.05$). It was obtained strong correlations between all the variables.

Conclusions: The measurements from the two computer-assisted cephalometric analysis are consistent. Clinicians can confidently use either of these programs.

Keywords: VistaDent, Nemoceph, Steiner analysis, Cephalometric radiographs

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INTRODUCTION

Lateral cephalograms play an important role in dentistry. Indeed, cephalometric measurements represent a key method for planning orthodontic treatment. Cephalometric evaluation is also used for case diagnosis, evaluation of treatment progress and growth, and prediction of surgical outcomes following treatment of dentofacial deformities. To accomplish all this, skeletal, dental, and soft tissue anatomical features need to be determined via a landmark identification and manual cephalometric analysis process for analyzing X-ray images. However, such an analysis requires an expert in the field of orthodontics and entails a time-consuming process (1,2).

Cephalometric measurements, which were traditionally performed manually, especially in the field of orthodontics, are now being replaced by digital cephalometric measurement programs. In fact, advances in computer technology have resulted in a greater adoption of digital systems for both viewing and analyzing cephalograms (3). These digital methods represent a sector of technology facilitating systems to obtain data, automatically calculate angles and linear measurements, and reduce mistakes in both landmark line drawing and measurements, and all with minimal human intervention (4). In addition, digital methods allow measurements to be carried out quickly, treatment plans to be easily determined, and images to be easily stored, reproduced, and sent anywhere in the world (5). Hence, the cost-efficient replication of radiographs and their rapid superimposition are among the advantages of such methods (6).

Various digital methods and computer software are now used for cephalometric tracing to assess the legitimacy and consistency of linear and angular measurements performed by programs such as Quick Ceph 2000 (Sarasota, Florida, USA), NemoCeph (Madrid, Spain), FACAD (Beilkegaten, Linkoping, Sweden), Vista Dent (Woodbridge, Canada), and OnyxCeph (Neidelwaldstr, Chemitz, Germany). The use of such software greatly supports orthodontic professionals in performing cephalometric evaluations and developing accurate diagnostic and treatment plans (7).

These technological advances have provided faster and better outcomes, which have helped to enhance clinical practices. However, despite the technological advances, there are still several types of errors (errors in the patient's head position and magnification) still occur in the cephalometric measurement process and need to be identified. To address this issue, the present study aims evaluate the reliability of angular measurements obtained from two-dimensional (2D) direct digital cephalometric radiographs. More specifically, this study is carried out to find out the validity of the free of cost and readily available imaging software such as VistaDent (Woodbridge, Canada) and NemoCeph (Madrid, Spain) for digital cephalometric tracing, by comparing its reliability of two different software programs. The null hypothesis is that the parameters obtained with Vista Dent and NemoCeph will be consistent with each other.

MATERIALS AND METHODS

The present research design was approved by the institutional ethical committee (approval no. 2022/02). The inclusion criteria for this study were a fully erupted permanent dentition, good-quality radiographs, and no previous history of orthodontic treatment. The exclusion criteria were patients with gross asymmetry, any dental syndromes, a history of orthodontic treatment and/or orthognathic surgery, and poor-quality radiographs. A total of 300 radiographs were collected based on the inclusion and exclusion criteria from archive of the orthodontics department of Hatay Mustafa Kemal University. For this study, the lateral cephalometric radiographs were obtained using a Vatech PaX-i SC digital panoramic and cephalometric imaging device (Gyeonggi, Korea). Direct digital exposures were made with 72 kV, 10 mA and a total scanning time of 20.2 s. Each radiograph was taken with the patient's Frankfort horizontal plane aligned parallel to the floor, and the jaws in centric occlusion.

Digital tracing

In the process of digital cephalometric measurement, digital cephalogram images were imported into the NemoCeph NX 2021 (Nemotec, Madrid, Spain) and Vista Dent software (GAC International, Inc., Bohemia, New York, USA). The images were calibrated by digitizing two points on the ruler within the digital image using the software provided by the manufacturer. Following digitization of the six anatomical landmarks, the Vista Dent and the NemoCeph programs automatically generated the measurements. (Table 1).

Statistical analysis

The statistical analyses were conducted using version 20.0 of the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA). The Shapiro–Wilk test was used to inspect the normality of the data distribution. The sella, nasion, A point (SNA; $80^0 \pm 2^0$) and sella, nasion B point

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(SNB; $78^0 \pm 2^0$) angles were revealed to be normally distributed, although the GoGn-SN angle ($36^0 \pm 2^0$) was not normally distributed. Thus, an independent samples t-test was performed to compare the SNA and SNB angle values and a Mann–Whitney U test was conducted to compare the GoGn-SN angles between the NemoCeph and Vista Dent tracings, as shown in Table 2.

Two weeks after the initial measurements were completed, 50 dijital radiographs and the associated measurements were repeated with the NemoCeph and Vista Dent software to determine the intraexaminer reliability using the intraclass correlation coefficient (ICC) for each measurement (8). Moreover, a clinically significant difference was identified when the discrepancy in the angular and linear measurements exceeded 2° or 2 mm, respectively.[9] The Pearson correlation was used to evaluate the consistency between the two measurement methods (Table 3).

Table 1. Description of cephalometric landmarks and measurements used in this study.

Landmark (abbreviation)	Definition
Sella (S)	Center of the pituitary fossa of the sphenoid bone
Nasion (Na)	Most anterior point on the frontonasal suture in the midsagittal plane
Point A (A)	Deepest point of the curve of the anterior border of the maxilla
Point B (B)	Most posterior point in the concavity along anterior border of the symphysis
Gonion (Go)	Point along angle of the mandible, midway between lower border of mandible and posterior ascending ramus
Gnation (Gn)	The most antero-inferior point on the contour of the chin, right in the middle of the lower edge of the mandible
Measurements	
SNA (º)	SN to NA angle
SNB (º)	SN to NB angle
SN/GoGn (º)	SN to GoGn angle

RESULTS

The ICC values ranged from 0.797 to 0.998, indicating good to excellent agreement between the two software programs. The differences in the SNA, SNB, and GoGn-SN angles between the two cephalometric analysis programs are shown in Table 2. In this regard, the differences in the measurements of the SNA, SNB, and GoGn-SN were not statistically significant between Vista Dent and NemoCeph ($p < 0.05$). The Pearson correlation analysis revealed a strong correlation between all the variables (i.e., strong correlation; Table 3).

Table 2. Comparison of the cephalometric measurements between the Vista dent and Nemoceph computerized softwares.

	Vistadent		Nemoceph		p
	Mean	SD	Mean	SD	
[a]**SNA (°)**	79.9	4.29	79.27	4.45	0.48
[a]**SNB (°)**	76.81	4.17	77.23	4.14	0.98
[b]**SN–GoGn (°)**	32.88	6.53	33.51	6.89	0.21

SD Standard deviation, [a]The results of paired t test, [b]The results of Mann-Whitney U Test

Table 3. Pearsons correlation: Comparison of mean values obtained from the Vista dent and Nemoceph computerized softwares.

Parameters being correlated	N	Correlation(r)	*p*
SNA (°)	300	0.970	<0.001
SNB (°)	300	0.972	<0.001
SN–GoGn (°)	300	0.931	<0.001

DISCUSSION

The lateral cephalogram is an essential tool for both evaluating skeletal growth and planning treatment and long-term follow-up of pre- and post-treatment changes (9). Due to the advancement of technology, the manual cephalometric tracing method is gradually being replaced by computer-based software, such as NemoCeph and Vista Dent (10,11). By using computer-assisted digital cephalometric analysis systems, the time required for tracing and analysis can be reduced, the inter- and intra-examiner errors can be eliminated, and the cephalometric results can be stored, used, and retrieved (12).

In computer-assisted cephalometric analysis, the location of landmarks is manually determined on the digital images, the cephalometric analysis is conducted using computer, and the cephalometric software program calculates the distances and angles automatically (13). However, these software programs are still associated with the potential for errors, irrespective of the clinician's experience who performs the manual landmark identification, which may lead to problems, for example, when transferring results (14,15).

The increasing use of digital cephalometric software has led to a need to compare the different software programs. Hence, this study aimed to evaluate the reliability of three angular measurements performed on 2D lateral cephalometric images derived from two rendering programs. Steiner's analysis was chosen for this study due to its widespread use as one of the most commonly applied cephalometric methods (16). All the measurements were performed by a single investigator with approximately 19 years of experience in cephalometric tracing. This approach was chosen to ensure standardization and minimize the errors that could

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arise between different operators, given the observation that the inter-examiner error rate is exceeds the intra-examiner error rate. Moreover, performing 10 tracings daily also contributed to reducing the investigator's stress and minimizing the errors (17).

According to the results of this study, the measurements obtained using the 2D VistaDent and NemoCeph tracing methods showed no statistical variations ($p > 0.05$). These results should be interpreted as indicating that Vista Dent and NemoCeph software can be used in place of each other, with no or only minimal systematic bias (18).

In many prior studies in which NemoCeph and manual tracing have been compared, no significant differences were found, suggesting that NemoCeph can be reliably used for cephalometric measurements (12,19). Comparable studies have also been conducted on desktop software such as AOCeph, NemoCeph, Quick Ceph, Dolphin, FACAD, Vista Dent and AutoCEPH. It was reported that the precision and dependability of the examined software to be comparable to manual cephalometric tracing, rendering the software suitable for use in diagnosis of the case, treatment planning, and assessment of treatment progress and results in clinical and research environments (17,19,20). However, the drawbacks of these desktop cephalometric software programs include the necessity of using them on a desktop or laptop, the high cost, and the need for an internet connection (12).

Still, Gorracci et al.(21) demonstrated the high consistency of cephalometric measurements taken using the iPad-based software SmileCeph, the desktop application NemoCeph, and manual tracing. In a study by Paul et al.(22), automated tracing (WebCeph) was associated with a higher number of landmark recognition errors compared to manual or semi-automatic tracing (NemoCeph), although both WebCeph and NemoCeph were found to be more reliable than manual tracing, with NemoCeph also demonstrating higher efficacy. For the present study, NemoCeph software was used due to its advantage over conventional tracing methods in terms of reducing observer errors (7).

Limitations

The study only used Steiner's analysis, which limits the generalizability of the findings. Using parameters from different analyses could lead to more valuable results.

CONCLUSION

The result of this study shows that the digital tracing with the NemoCeph had equal accuracy in comparison to the Vista Dent. This study determined that the measurements obtained from the two computer-assisted cephalometric analysis programs (NemoCeph and Vista Dent) currently in use are compatible with each other, indicating that both programs can be reliably used by clinicians.

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Not Applicable.

Authorship contributions

Zortuk FB: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision. Küçük EB: Writing – original draft preparation, Writing – review and editing, Visualization, Supervision.

Data availibity statement

The data used in this paper is publically available through Hatay Mustafa Kemal University's research repository.

Declaration of competing interest

No conflict of interest was declared by the authors.

Ethics

The present study was approved by the institutional ethical committee (approval no. 2022/02).

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MMDJ
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