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Research

Cephalometric analysis: Orthodontists versus oral radiologists

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ABSTRACT

Background: Orthodontists evaluate the cephalometric analysis in order to determine a correct diagnosis. In clinical practice, oral radiologists are the group of specialists who run this test. However, due to several factors, some orthodontists feel the need to confirm the results reported by oral radiology clinics and perform the cephalometric analysis again. The main objective of this study was to assess the consistency among cephalometric measurements obtained by orthodontists and radiologists using computerized cephalometric analysis software.
Methods: Thirty orthodontists and 30 oral radiologists identified 18 cephalometric landmarks using the same computer, as directed by the software Radiocef Studio 2®. From there, 14 cephalometric parameters were generated. In order to verify the intraexaminer agreement, 10 professionals from each group repeated the identification of the landmarks with a minimum interval of 8 days between the two markings. The intragroup variability was calculated based on the coefficients of variation. The comparison between groups was performed by using the Student *t*-test and the Mann–Whitney test.
Results: In the group of orthodontists, the measurements of Pog and 1-NB, SL, line S-Ls, Line S-Li, and 1.NB showed high internal variability. In the group of radiologists, the same occurred with the values of Pog and 1-NB, line S-Ls, Line S-Li, and 1.NA. In the comparison between groups, all the analyzed linear measurements (Pog and 1-NB, SL, Line S-Ls, and Line S-Li) and two angular measurements (1.SN and AF) showed statistically significant differences between radiologists and orthodontists ($P < 0.05$).
Conclusion: All linear measures assessed (and only two angular measures) indicated an inconsistency between orthodontists and radiologists.

1. Introduction

Cephalometric analysis is the measurement of linear and angular data on the radiograph, through localization of landmarks, distances, and lines within the facial skeleton [1]. Two approaches can be used for its realization. The manual approach is the oldest and consists of placing a sheet of acetate on the radiograph, in which the professional draws the main anatomical structures and identifies the cephalometric landmarks. With the aid of a ruler, the professional connects the landmarks to each other and originates the lines and cephalometric plans. The intersection of these lines and planes generates linear and angular data that can be measured using a ruler and protractor [2].

In the computerized approach, the landmarks are identified by the professional with the aid of the mouse on the computer screen, in digital radiographs, or on scanned images from analog radiographs. After that, computer software automatically completes the analysis by measuring distances and angles [2].

In clinical practice, orthodontists are the group of specialists who most often evaluate the cephalometric analysis, taking into account its importance in determining a correct diagnosis and orthodontic treatment plan. On the other hand, oral radiologists are the group of specialists who more often run this test. However, due to several factors, some orthodontists feel the need to confirm the results reported by oral radiology clinics and perform the cephalometric analysis again. The literature has many studies evaluating the validity and reliability of cephalometric analysis methods [3–5], as well as much research comparing manual and computerized cephalometric analyses [1,6,7]. Other studies have confronted the

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different types of software used for cephalometric analysis [8–10]. However, the literature is sparse regarding studies comparing the variability of the results obtained from the same cephalometric analysis performed by orthodontists and oral radiologists.

This research aimed to assess (1) the variability of the cephalometric measurements obtained by orthodontists by using computerized cephalometric analysis software, (2) the variability of the cephalometric measurements obtained by oral radiologists, and (3) the consistency among cephalometric measurements obtained by orthodontists and oral radiologists by using computerized cephalometric analysis software. The following null hypotheses were tested: (1) cephalometric measurements obtained by orthodontists show low intragroup variability, (2) cephalometric measurements obtained by oral radiologists show low intragroup variability, and (3) cephalometric measurements obtained by orthodontists and oral radiologists are consistent with each other.

2. Materials and methods

The project for this research was submitted to the Ethics Research Committee of the University Hospital Onofre Lopes and approved under Opinion No.,732 452.

The research material was selected from an oral radiology clinic file and consisted of a radiograph in lateral view with a quality digital image and size of 2100 × 2092 pixels. The image acquisition was carried out through use of a Kodac 8000C® appliance (Carestream Health Inc., Rochester, New York [14-bit grayscale]).

The selected radiograph should meet the following criteria: adult patient older than 21 years for males or 18 years for females, with no tooth loss and with correct posture during radiography [11]. Radiographs that presented supernumerary elements, anodontias, fixed orthodontic appliance, or pathologies were excluded from the selection. These criteria were evaluated on panoramic radiographs acquired at the same time of the radiograph. Further, no patient identification should be contained on the radiographs.

2.1. Characteristics of the sample

The sample size calculation was based on a pilot study in which 30 subjects per group were tested, considering the following parameters: alpha error (0.05), beta error (0.20), smallest difference between the averages (0.64), standard deviation in group 1 (1.009), and standard deviation in group 2 (0.62), resulting in 27 subjects per group. Therefore, the actual sample tested in the pilot study became the main study sample.

The elected samples were 30 dentist specialists in orthodontics and 30 dentist specialists in oral radiology, who had at least 3 years of experience in the field. Specialists who were not active in the profession or specialization were excluded.

2.2. Data collection

Each examiner identified 18 cephalometric landmarks (Table 1) in a single radiograph, as directed by Radiocef Studio 2® software (Radiomemory®; Belo Horizonte, Minas Gerais, Brazil). The image calibration was standardized at 200 dpi, and all examiners identified the location of the landmarks on the same computer in order to minimize possible errors due to different resolutions. Examiners were allowed to use any of the software's image-enhancing features to better visualize structures. The cephalometric measurements presented in Table 2 were automatically generated after identification of the landmarks.

In order to verify the intraexaminer agreement, 10 orthodontists and 10 oral radiologists repeated locating the landmarks with a minimum interval of 8 days between the two markings. Outcome was assessed using the intragroup correlation coefficients (ICCs). In the following tests, the reading of the first marking was used.

Table 1
Cephalometric landmarks

Landmark	Definition
N (Nasion)	The most anterior point of the nasofrontal suture
Or (Orbitale)	The lowest point of the external body of the orbital cavity
S (Sella)	The centre of the pituitary fossa
Po (Anatomical Porion)	Highest point of the ear canal
Go (Gonion)	The most posterior inferior point on the outline of the angle of the mandible
Pog (Pogonion)	The most anterior point on the symphysis
Gn (Gnation)	The most anterior inferior point on the bony chin in the midsagittal plane
B (Point B)	The most posterior point in the curvature along the border of the symphysis
D (Point D)	The center of the symphysis
A (Point A)	The most posterior point on the maxilla between the anterior nasal spine and the alveolar process
Aii	Radicular apex of the lower central incisor
Iii	The incisal tip of the lower central incisor
Ais	Radicular apex of the upper central incisor
Iis	The incisal tip of the upper central incisor
Pog' (Soft tissue Pog)	The point on the anterior curve of the soft tissue chin
Li (Labrale inferior)	The most anterior curve of the lower lip
Ls (Labrale superior)	The most anterior curve of the upper lip
Prn (Medium pronasale)	Midpoint on the lower curve of the nose

2.3. Data analysis

The research database was built in the SPSS® software platform (Statistical Package for Social Sciences) version 22.0 for Windows. The distribution of the data was tested based on the criteria: asymmetry, kurtosis, and standard deviation. The intragroup variability was evaluated by coefficient of variation (CV). The comparison between groups was performed using the Student *t*-test for independent samples and for variables with normal distribution and using the Mann–Whitney test for those with non-normal distribution. In all cases, the significance level of 5% was considered.

3. Results

Table 3 shows the results of the intraexaminer agreement. The group of orthodontists showed more satisfactory agreement than

Table 2
Cephalometric measurements

Measurement	Description
SNA	Angle between the SN and NA lines
SNB	Angle between the SN and NB lines
SND	Angle between the SN and ND lines
SN.GoGn	Angle between the mandibular plane (Go-Gn) and the SN line
AF	Angle between the Frankfurt plane (Po-Or) and the N-Pog line
SL	Linear distance between the S and L points (point automatically generated by the software, on the SN line, by drawing a perpendicular to the SN line passing through the Pog point)
1. SN	Angle between the long axis of the upper incisor and the SN line
1.NA	Angle between the long axis of the upper incisor and the NA line
1.NB	Angle between the long axis of the lower incisor and the NB line
IMPA	Angle between the mandibular plane (Go-Gn) and the long axis of the lower central incisor
Pog e 1-NB	Difference between the Pog-line NB and Iii-line NB distances
1.1	Angle formed by the intersection of the long axis of the upper incisor with the long axis of the lower incisor
Line S-Ls	Distance between the S line (Prn-Pog') and the Ls point
Line S-Li	Distance between the S line (Prn-Pog') and the Li point