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Manual and Computerized Lateral Cephalometric Analysis Methods, Is There Any Difference?

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Abstract-Objectives: To compare hand tracing and computerized tracing methods and to determine any difference exists between the two methods with intraobserver and interobserver examiners.

Methods and Materials: Forty lateral cephalometric film radiographs were obtained under standardised conditions, of male and female patients of various age groups. The radiographs were traced and angular and linear measurements were analyzed by two examiners, each performed the manual tracing and computerized tracing using Dental vision programme of all 40 radiographs. Mann –Whitney test was applied to examine the differences.

Results: Upper central toNA linear measurement (P=0.014), Lower central incisor to NB linear measurement (P=0.019) and lower incisor angle (P=0.009) were the only parameters found to be significantly different between the two examiners. There was no significant difference between both examiners 1 and 2 for the hand-tracing method, and computerized method for any measurement. All measurements were comparable between the two methods.

Conclusion: This study validates the use of tracings obtained from computer-assisted cephalometric analysis, as the values recorded were mostly not statistically significant between inter- and intra examiner tracings, by both manual and computerized method.

Keywords-*Cephalometrics, Handtracing, Computerized Tracing, Dentalvision, Measurements*

I. INTRODUCTION

Since Broadbent [1] and Hofrath [2] introduced the cephalometry in1931, cephalometric analysis has contributed to the analysis of malocclusion and it has become a standardized diagnostic method in orthodontic practice and research. [2–4] Two approaches may be used to perform a cephalometric analysis: a manual approach, and a computer aided approach. The manual approach is the oldest and most widely used. Landmark identification is the main source of error in the manual technique. [5-8] It can depend on visual performance, training, and experience of the clinician, and the density and sharpness of the image. [9] The other approach is computer aided. Computerized cephalometric analysis uses manual identification of landmarks, and the computer software completes the cephalometric analysis by automatically measuring distances and angles. Computer aided cephalometric analysis can eliminate errors such as those in certain cases traditional method produced more precise results [11]. The measurements performed in the computer analysis were comparable to manual measurements, with no statistically significant difference [12].

The purpose of this study was to compare the manual method of tracing with a computerized method and inter- and intra-observer errors were investigated for differences between two methods.

II. MATERIALS AND METHODS

Sample selection The following materials were used: 40 adult lateral cephalometric radiographs; one 0.5 mm propelling pencil; a cephalometric kit; light box; Dental vision computerized system (computer forum GmbH Elmshon Germany, Figure 1).

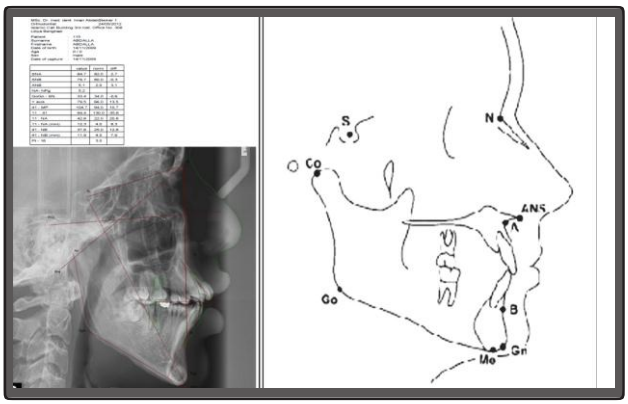

Figure 1. Left : Tracing with computer program Dental-vision, Right: steiner analysis

The lateral cephalometric radiographs were taken under standardized conditions in the same radiological center and they were randomly selected, included both male and female patients with different age groups. Figure 2 shows the manual tracing of one of the patients.

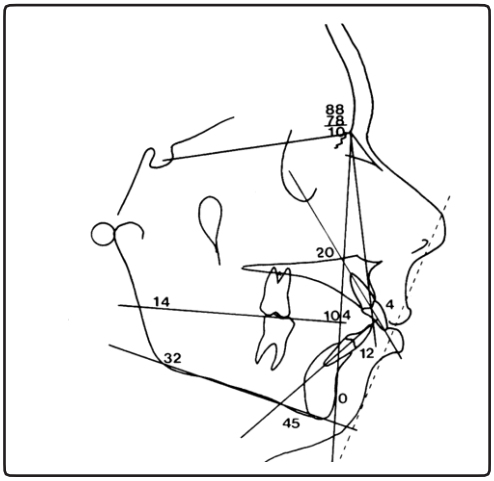

Figure 2. Manual tracing for one of the patient

The lateral cephalometric radiographs were taken under standardized conditions in the same radiological center and they were randomly selected, included both male and female patients with different age groups. Figure 2 show the manual tracing of one of the patients.

The manual and computerized methods were used to measure the radiographs by two examiners with 8-10 years experience, named examiner-1 and examinar-2.Step one;examiner -1did analysis for 20 lateral cephalometric radiographs using both the manual method and computerized method; and examiner-2 also did analysis for 20 lateral cephalometric radiographs using both the manual method and computerized method. Step two; after each examiner had measured their 20 radiographs, the x-rays were exchanged between the two examiner to evaluate inter and intra-examiner performance. Each examiner evaluated 40 radiographs. In order to reduce the errors during the study and to standardize the study, all the drawing of anatomical structures and cephalometric landmarks were made using a light box in a dark room. Each examiner evaluated a maximum of 8-10 radiographs per day, in order to avoid fatigue leading to casual errors.

The following measurements were evaluated: Six angular measurements: SNA angle - formed by the intersection of S-N and N-A lines; SNB angle - formed by the intersection of S-N and N-B lines; ANB angle-formed by the intersection of A-N and N-B lines; IMPA angle - determined by the intersection of Tweed's mandibular plane and the axis of the lower central incisor; :U1-NA angle- formed by the intersection of long axis of upper central incisor and N-Alines; L1-NBangle- formed by the axis of the lower central incisor and the NB line; two linear measurementsU1-NA - distance between the incisal border of the upper central incisor, more prominent, and the NA line; L1-NB - distance between the incisal border of the lower central incisor, more prominent, and the NB line.The analytic readings were recorded on a record sheet and later tabulated on a computer. For computerized analysis, the radiographs were digitized and stored in a computer. Later, radiographs were imported into the dental vision program and calibrated in order to avoid any distortion of the program with the original radiograph. Next, landmarks were identified using a mouse-cursor on the displayed digital image and computer software (Dental Vision) completes the cephalometric analysis by automatically measuring distances and angles. The program issued a cephalometric tracing and a table of angular and linear measurements for each radiograph and this data provided by the program was saved.

III. STATISTICAL ANALYSIS

The measurements collected from both methods were organized in tables and analysed. The statistical analysis in this study used was Mann-Whitney test. It is a non- parametric test used to compare two independent and same size samples.

IV. RESULTS

The mean differences and standard deviations for each of the six measurements of the examiner-1 with the manual technique and Dental vision software program are shown in Table 1.

TABLE I. MEAN OF THE MEASUREMENTS OBTAINED FROM BOTH METHODS OF EXAMINAR1 AND THE RESULTS OF THE MANN-WHITNEY-TEST

Measurements	Manual μ1 ± SD	Computerised μ2 ± SD	P-Value
SNA(degree)	80.80± 4.914	80.57 ± 5.026	0.937 n.s
SNB(degree)	77.93 ± 4.559	77.29 ± 4.409	0.603n.s
ANB(degree)	2.98 ± 2.421	3.28 ± 2.498	0.610 n.s
U1NA(degree)	25.20 ± 8.659	25.35 ± 9.338	0.948 n.s
U1NA (mm)	7.31 ± 4.808	5.26 ± 4.918	0.024*
L1NB(degree)	26.20 ± 7.054	28.08 ± 7.471	0.231 n.s
L1NB (mm)	7.46 ± 2.700	6.27 ± 3.012	0.070 n.s
IMPA(degree)	92.76 ± 7.330	96.28 ±13.935	0.321 n.s

MEAN(μ)±
STANDARD DEVIATION(SD)
n.s=Nonsignificant
* (P<0.05)

When the two techniques were compared with respect to differences in the means, no statistically significant differences were found for the examiner- 1measurements, For the examiner-2, the differences for U1-NA ($P < 0.05$)distance measurements were statistically significant (Table2).

TABLE II. MEAN OF THE MEASUREMENTS OBTAINED FROM BOTH METHODS OF EXAMINAR2 AND THE RESULTS OF THE MANN-WHITNEY-TEST

Measurements	Manual $\mu 1 \pm SD$	Computerised $\mu 2 \pm SD$	P-Value
SNA(degree)	79.74 ± 5.483	80.52 ± 5.093	0.584 n.s
SNB(degree)	77.46 ± 4.246	77.62 ± 4.216	0.820 n.s
ANB(degree)	2.30 ± 2.813	2.93 ± 2.938	0.288 n.s
U1NA(degree)	26.19 ± 8.769	27.33 ± 8.806	0.417 n.s
U1NA (mm)	7.50 ± 4.709	6.71 ± 4.456	0.375 n.s
L1NB(degree)	27.80 ± 7.544	27.68 ± 7.103	0.784 n.s
L1NB (mm)	6.78 ± 2.732	6.05 ± 2.419	0.233 n.s

V. DISCUSSION

The manual method is the most common method applied for cephalometric analysis and studies have reported the major sources of errors arise from tracing, landmark identification, and measurements.[13] These errors can be minimized by understanding the anatomic structure of the region, experience of the observers, and by repeated measurements5 Advances in computer technology have led to increasing use of computer software programmes both for tracing and analyzing. Previous studies have proved that the main advantages of computerized analysis are the information access, improved data storage, and image manipulation,[14] and time saving characteristics,[15] when compared to manual cephalometric analysis. Many experimental studies have showed, there was no significant difference between measurements by the manual and computerized analysis. [11, 12] The main difficulties in the field of cephalometry remain the lack of a gold standard for the cephalometric variables. In these type of studies, cephalometric land marks were selected, depending on the ease of locating the landmarks, providing higher reliability and precision, which can directly influence the measurement. [16] All these measurements were based on nation localization and the differences may be due to difficulty in identification at this point. When identifying landmarks described as being more inferior or deep in a given bone contour, for example, points N, A and B, the computerized method proved to be more reliable than the manual method. Studies have proved equally difficult in reproducing, points N, A and B, in both methods. [11, 14] In this study, linear measurement U1NA reported stastically significant difference when both, manual and computerized tracings of examiner 2 compared, and when examiner1manual tracings with examiner 2 computerized tracings. The results found in this study were similar to the results of few studies.[17, 18] Another linear measurement L1NB was observed stastically significant, when examiner 1 computerized tracings with examiner 2 manual tracings were compared. The differences between the inter observer results were due to error derived from several sources. When manual and computerized methods were compared, angular measurements showed no stastically significant differences between inter examiner measurements. However, one angular measurement, IMPA angle showed stastically significant difference, the manual tracings of examiner 2 with computerized tracings of examiner1.This could be due to difference in locating the landmark gonion, which was taken as intersection of two tangents (posterior border of the mandible and the lower border of the mandible) manually, whereas in program only the points, that is one point at a tangent to posterior border of the mandible and the other was a point tangent to the inferior border of the mandible were marked. Gonion identification is difficult due to a poorly defined anatomical outline, a double image and localization away from the midsagittal plane [19]. Significant differences in Gonion, lower incisor apex points localization showed both horizontal and vertical variations and lead to errors in measurements regardless of the method. [20] With the application of computers in the studies provide significantly more accurate measurements due to the intrinsic characteristics of measuring computer pixels.

VI. CONCLUSION

There were no significant differences between two methods. Only three measurements showed statistical significant difference (U1NAlinear, L1NBlinear, IMPA angle measurements). This study provides support for transition from manual to computerized analysis method.

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