An Evaluation of the Accuracy and Reproductibility of Cephalometric Measurements Using Two Different Versions of Romexis Software

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Abstract— **The present study was designed to determine the reliability and reproductibility of angular and linear cephalometric measurements obtained with two different versions of Romexis Planmeca imaging software. 48 pre-treatment orthodontic X-rays were selected for the present study. All the radiographs were measured by two observers, and traced under Steiner and Tweed analyses. The digital tracing was performed using Romexis imaging software version 3.2.0 and the updated year 2014 – compatible version 3.6.0 R. When compare the results found for Romexis 3.2.0 and the other one found for Romexis 3.6.0 R, our reserche sustain, based on the statistical results, that Romexis version 3.2.0 is more accurate and reproductible.**

Keywords— **cephalometry, image resolution, statistical analysis, Steiner analysis, Tweed analyses.**

I. INTRODUCTION

Cephalometry is mostly used in orthodontics, to describe the morphology and the growth of the facial skeleton, predict growth, plan treatment and evaluate treatment results [1, 2]. To performe a cephalometric analysis, the orthodontists mark specific and standard anatomical landmarks on the radiographs, and measure various angular and/or linear parameters. Image thickness and resolution, anatomical complexity and superimposition of hard and soft tissue, and the experience of the observers when looking for a particular landmark are important factors that can influence the identification of the landmark [3]. Currently, radiology field has developing towards digitization and computerization.

Planmeca RomexisTM Software is one of multiple digital software present on the medical market in these days. The software was invented and designed by Planmeca Oy, Finland and can very easily to capture, view, manipulate and process the 2D or 3D images, depend what is nedeed. Romexis software functionalities are concepted to solve many directions which are included in dental area. Moreover, Planmeca Romexis developed different module for 2D and 3D imaging, 2D and 3D diagnosis, cephalometric assessment, orthodontists and dental labs, dental model analysis, treatment planning in 3D, export of digital dental models in STL format, cephalometric analyses and superimpositions, implant planning, dental imaging needs, and the last but not the least, special modules for dental education and unique concept for clinic management and maintenance. A comparison between digital to conventional radiography demonstrates several advantages, particullary in implant and endodontic treatment [4]. Several studies have examined the accuracy and reproducibility of measurements using different cephalometric methods, and then reported the fact that direct method is considerate more reproducible and more accurate; moreover, the conclusion was that the differences between the methods are insignificant for majority of them.

II. MATERIALS AND METHODS

Digital cephalometric exams of 48 pre-treatment orthodontic radiographs were selected for the present study from the archive of the private radiological center. The patients distribution was 21 males and 27 females, and their ages ranged between 7 - 33 years. All the radiographs were measured individually by two observers, in which linear and angular measurements were made using the same 2D computerized cephalometric X-ray, and traced with 2 different version of Romexis imaging software, both under Steiner and Tweed analyses for all the sample.

For the acquisition of the lateral cephalometric images, we use in the study the same device, a Planmeca ProMax 3D Mid (Planmeca, Helsinki, Finland) and the tehnician use the same protocol: the head of the subjects were positioned in the cephalostat with the sagittal plane perpendicular to the path of the ground, Frankfort Horizontal plane was parallel to the floor, the teeth were in their centric occlusion and the lips were in repose. For the next step the digital images were transfered into Romexis Planmeca software database.

The digital tracing was performed using Romexis imaging software version 3.2.0 and the updated year 2014 – compatible version 3.6.0 R (Planmeca, Helsinki, Finland); No more 10 radiography were traced on a single day. Digital Imaging and Communications in Medicine

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(DICOM) files obtained with our device were subsequently visualized, separatelly by each observers, with the Planmeca Romexis program and digitized on a 16 : 9, 23 - inch, Light Emitting Diodes (LED) backlighting monitor display (Dell, USA) at a screed resolusion of 1920 × 1080 pixels. Both version of software were instaled on the same computers, first one was version 3.2.0 and after the updated process was used the second one, version 3.6.0 R. Observer 1 and observer 2 traced on the same computers. The software, regardless of the version used for cephalometric tracing, permitted to the resercher to adjust the images using functions for brightness, zoom and contrast; in plus, version 3.6.0 R have one more function than 3.2.0 version, filter function, which help the observer to offer better clarity to the radiographs. Before starting to identify the anatomical landmarks, both observers made individually, the calibration of the images, by selected two points on the X-rays ruler from up-right side. 13 angular and 11 linear (Fig. 1 and Fig. 2), commonly used to assess the dentofacial relationships, were selected to sustain the present reserche.

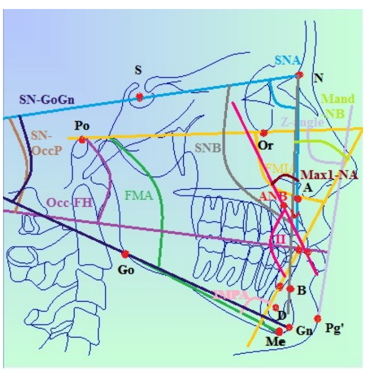

Fig. 1 Angular measurements developed under Steiner and Tweed analysis

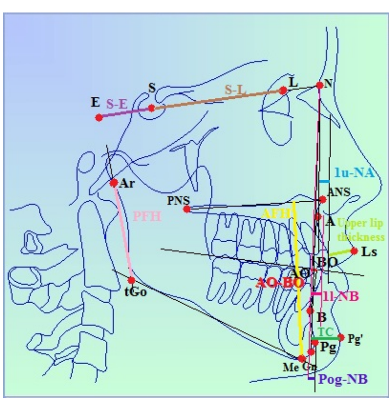

Fig. 2 Linear measurements developed under Steiner and Tweed analysis

Next step, which were performed by the observers, was landmark identification which was carried out manually on the digital cephalometric images using a mouse cursor. Following digitalization of landmarks, measurements were automatically generated by the imaging software and a report sheet model was issued for each radiograph.

III. Results and Discussions

Statistical analysis for the present research was based on the Scheffe test. The parameter p was our reference and the meaning of this parameter is the significance level of the test (p = 0.05), for a confidence interval of 95%. The results were presented as mean ± SD. The results from our study show significant differences in both type of analysis, Steiner and Tweed analyses. Moreover, in Tweed analysis, interobservers reproducibility for Romexis 3.2.0 were found significant for parameters AO-BO, Z-Angle and Facial height index, and for Romexis 3.6.0 R the interboservers reproducibility were found significant for SNA and Facial height index. A comparison between Romexis 3.2.0 and Romexis 3.6.0 R measurements showed significant differences in AO-BO and Z-Angle.

For parameter SNA, from Tweed analysis, there were no significant differences between the mean values of Observer 1 and Observer 2 for Romexis 3.2.0; In Romexis 3.6.0 R SNA shows significant differences between Observer 1 and Observer 2 (p=0.0074); and the statistical analysis revealed no significant differences between the measurements of the two versions of software (Fig. 3).

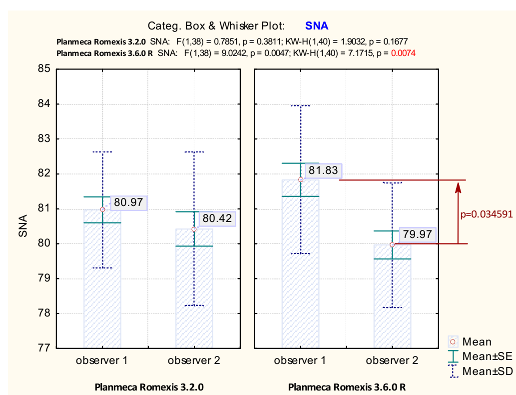

Fig. 3 Statistical analysis perfomed for **SNA** parameter; the graphics show the interobservers and intersoftware reproducibility.

For parameter AO-BO, from Tweed analysis, there were significant differences between the mean values of Observer 1 and Observer 2 for Romexis 3.2.0 and for Romexis 3.6.0 R. A comparison between Romexis 3.2.0 and Romexis 3.6.0 R for Observer 2 shows significant differences for AO-BO measurements (p=0.03) (Fig. 4).

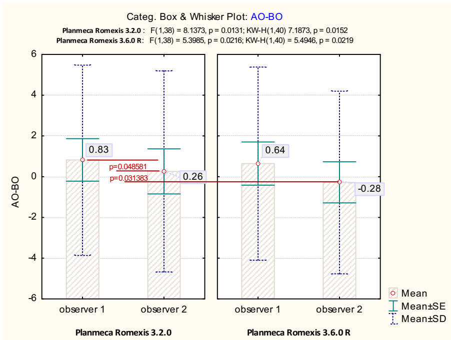

Fig. 4 Statistical analysis perfomed for **AO-BO** parameter; graphics show the interobservers and intersoftware reproducibility.

For parameter Z-Angle, from Tweed analysis, were significant differences between mean values of Observer 1 and Observer 2 for Romexis 3.2.0. A comparison between Romexis 3.2.0 and Romexis 3.6.0 R show significant differences between Observer 2 and Observer 1 (Fig. 5).

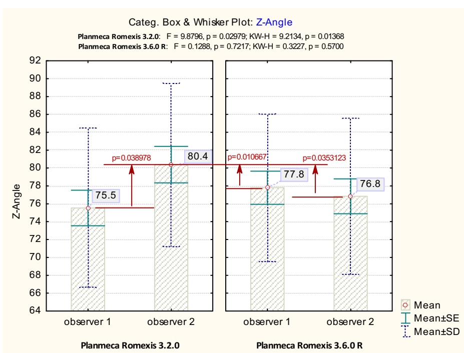

Fig. 5 Statistical analysis perfomed for Z-Angle parameter; graphics show the interobservers and intersoftware reproducibility.

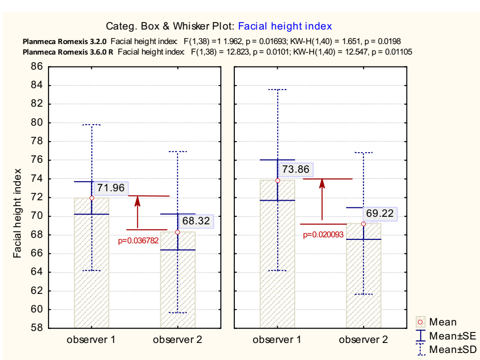

Fig. 6 Statistical analysis perfomed for **Facial height index** parameter; graphics show the interobservers and intersoftware reproducibility.

For parameter Facial height index, from Tweed analysis, were significant differences between mean values of Observer 1 and Observer 2 for Romexis 3.2.0 and Romexis 3.6.0 R; No significant differences were observed between the measurements of the two versions of software (Fig. 6).

On the other hand, for for the second analysis used in our study, Steiner analysis, a comparison between observers, for Romexis 3.6.0 R, showed significant differences for Interincisal angle, Max1-NA and Max1-SN measurements. A comparison between Romexis 3.2.0 and Romexis 3.6.0 R showed significant differences for Observer 1 for Interincisal angle, Max1-NA and Max1-SN measurements.

For the parameter Interincisal angle, from Steiner analysis, there were significant differences between Romexis 3.2.0 and Romexis 3.6.0 R for Observer 1. A comparison between Observer 1 and Observer 2 for Romexis 3.6.0 R shows significant differences for the Interincisal angle (Fig. 7).

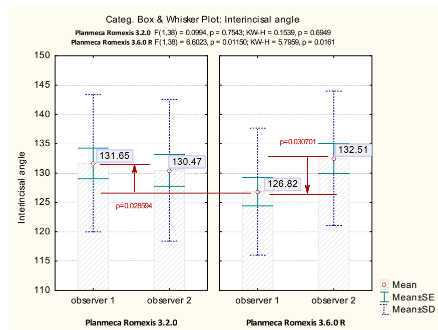

Fig. 7 Statistical analysis perfomed for **Interincisal angle** parameter; graphics show the interobservers and intersoftware reproducibility.

Parameter Max1-NA, from the Steiner analysis, was found with significant differences between observers for Romexis 3.2.0 and also for Romexis 3.6.0 R; For Observer 1 the statistical analysis found significant differences between the softwares (Fig. 8).

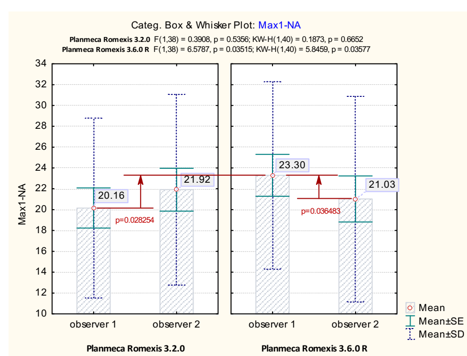

Fig. 8 Statistical analysis perfomed for **Max1-NA** parameter; graphics show the interobservers and intersoftware reproducibility.

Parameter Max1-SN, from the Steiner analysis, was found with significant differences between observers for Romexis 3.6.0 R; A comparison between softwares found significant differences for Observer 1 (Figure 9).

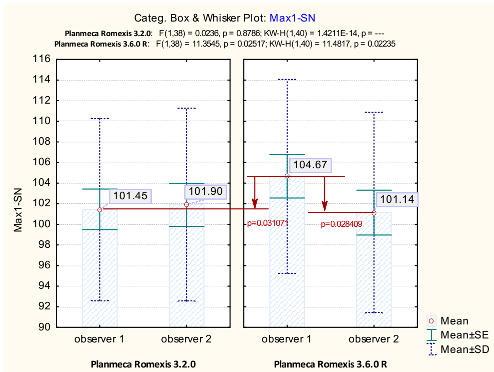

Fig. 9 Statistical analysis perfomed for **Max1-SN** parameter; graphics show the interobservers and intersoftware reproducibility.

However, for Romexis 3.6.0 R, Tweed analyses, there were significant differences in SNA and Facial height index. SNA values between the Observer 1 (81.83 ± 2.12) and Observer 2 (79.97 ± 1.79) measurements with p-value Scheffe test=0.034591; Facial height index between Observer 1 (73.86 ± 9.71) and Observer 2 (69.22 ± 7.61) measurements with p-value Scheffe test = 0.020093

For Steiner analysis there were significant differences in Interincisal angle, Max1-NA and Max1-SN. Interincisal angle values between the Observer 1 (126.82 ± 10.83) and Observer 2 (132.51 ± 11.46) measurements with p-value Scheffe test=0.030701; values between the Observer 1 (23.3 ± 9.0) and Observer 2 (21.0 ± 9.8) measurements with p-value Scheffe test=0.036483; values between the Observer 1 (104.67 ± 9.41) and Observer 2 (101.14 ± 9.75) measurements with p-value Scheffe test=0.028409;

For Romexis 3.2.0, Tweed analyses, there were significant differences in AO-BO, Z-Angle and Facial height index. AO-BO values between the Observer 1 (0.83 ± 4.67) and Observer 2 (0.26 ± 4.94) measurements with p-value Scheffe test=0.048581; Z-Angle values between Observer 1 (75.53 ± 8.93) and Observer 2 (80.38 ± 9.13) measurements with p-value Scheffe test=0.038978; Facial height index values between Observer 1 (71.96 ± 7.80) and Observer 2 (68.32 ± 8.61) measurements with p-value Scheffe test=0.036782. For Steiner analysis there were found no statistically significant differences between observers.

In this reserche, the comparison of Romexis 3.2.0 and 3.6.0 R imaging program for cephalometric analyses demonstrated that only the variales SNA, Interincisal angle, Max1-NA, Max1-SN, AO-BO, Z-Angle and Facial height index presented significant differences; one of them presented a small differences between versions but was considerated statistical significant. The other variables did not present any siginificant differences between the two versions of Romexis software. Owing to these results it can be assumed that both version of Romexis imaging program could be fairly relible methods, noting that Romexis 3.6.0 R holds more functions that may be helpful than 3.2.0 version.

A possible explication for these significant differences between these two versions of imaging program can be caused by the clarity of the radiographs, which was better for Romexis 3.6.0 R after apply the filter function; another possible explanation for the existence of these errors might be caused by the difficulty identification of points A, N, Pg' and occlusal plane. Similar results were evidenced also by other researchers [5, 6].

IV. CONCLUSIONS

In our computerized digital cephalometric analysis, the differences of measurements between observers and the two versions of Romexis imaging program were authentic. The reliability of variables was comparable except for the SNA, Interincisal angle, Max1-NA, Max1-SN, AO-BO, Z-Angle and Facial height index measurements. When compare the results found for Romexis 3.2.0 and the other one found for Romexis 3.6.0 R, our reserche sustain, based on the statistical results, that Romexis version 3.2.0 is more accurate and reproductible.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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