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Research Article

Evaluation of Orthodontic Digital Setup Accuracy using the Scanner Orthoinsight 3D®

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Abstract

Background: Digital technology applied to dentistry has increased in the past few years playing an important role in diagnose and treatment planning. In this context, digital 3D scanners have been introduced on market and despite the primary purpose of digital dental data storage; scanners commonly offer other working tools, as for example, digital setup.

Objective: The aim of the present study was to verify the digital setup accuracy using the scanner Orthoinsight 3D® comparing with the conventional setup technique.

Material and Methods: Sample size was calculated and 23 patients were randomly selected for the study. Conventional and digital setups were obtained according to well established guidelines and intercanine, intermolar and arch length were thus measured in both techniques.

Results: None of the parameters accessed showed statistically significant differences ($p > 0.05$), between the setup mounting methods.

Conclusions: The present results suggest that if properly constructed the digital setup is a viable and useful tool for treatment planning in orthodontics.

Keywords: Orthodontics; Setup; Treatment Planning; Digital Model; Scan

Introduction

Orthodontic treatment planning is based on a detailed and meticulous investigation on the dental, skeletal, medical, behavioral, psychological, hereditary and other characteristics of the patient. In order to access dental information, plaster models are considered essential diagnose tool. If taken under the correct technique, dental casts reproduce accurately the dental arch, allowing evaluation of arch symmetry, tooth dimension, teeth/arch discrepancy, Spee and Wilson curve and other particularities [1]. In addition, dental casts allow 3D visualization of the occlusion; enable prospective simulation of surgeries and setup [2].

Conventional orthodontic set up consists in occlusion reprogramming using initial plaster models aiming to verify the applicability of one or varied treatment plans [3]. Conventional setup is undoubtedly an important planning tool, however, the mounting technique is methodic and time consuming. Plaster models can be lost, broken or contaminated over time. Moreover, dental casts need large storage space and are difficult means for professional exchange [4]. Digital technology applied to dentistry has increased in the past few years playing an important role in diagnose and treatment planning. In this context, digital 3D scanners have been introduced on market and despite the primary purpose of digital dental data storage; scanners commonly offer other working tools, as for example, digital setup [5]. Many studies have been published aiming to verify digital models accuracy, but other features such as digital setup tool have not been fully tested. The aim of the present study was to verify the digital setup accuracy using the scanner Orthoinsight 3D® comparing with the conventional setup technique.

Materials and Methods

For the present study, 23 patients were randomly selected from the total of 575 finished treatments belonging to Bahia Federal University Orthodontics Post Graduation Program. Sample size was calculated using a maximum expected difference of 1,0mm.

The power of the test and alfa level was set at 95% and 5%, respectively. The following inclusion criteria were established: corrective orthodontic treatment concluded, no missing teeth (except third molars), no prosthetic treatment, no growth potential, no orthognatic involvement and perfect initial dental casts and conventional plaster/wax setups available. Prior to the beginning of the treatment, conventional setups were obtained from initial models using the guidelines reported previously [3].

To produce the digital models, Orthoinsight 3D® version 5.0 (Motionview Software, LLC, Chattanooga, Tennessee, USA) scanner was used, which features a laser beam and digital cameras capable of capturing high-resolution images. A well trained orthodontist scanned the models according to the specifications provided by the equipment manufacturer. The initial models, final models, and conventional setups were scanned. The wax areas (not detectable by the laser) were covered with the solvent developer Spotcheck SKD-S2 (Magnaflux, Glenview, Illinois, USA).

For the digital setup construction, initial models were scanned. The researcher obeyed the same guidelines established for the conventional setup mounting and executed treatment plan, such as anchorage, final desired position for maxilla and mandible, expected torque, amount of overcorrection for rotation control, arch forms, etc. No access to the conventional setup or final model was allowed during digital set up making (conventional setup and final models were scanned posteriorly). The digital setups were constructed based on the initial models scans using the software Mottionview (Motionview Software, LLC, Chattanooga, Tennessee, USA). Initially, the upper and lower arch forms were obtained and the crown axis determined. The teeth were sectioned one by one, preserving the anatomy of the tooth crown in the mesiodistal and buccolingual directions (Figure 1A), while ensuring that each section extended right through the contact point. After this stage, manual adjustment of individual teeth to their ideal positions was performed according to the treatment plan. Arch form and midline were determined using a specific tool available in the software. Extractions were then performed according to the planning. The mounting was initiated by repositioning posterior teeth. One side was mounted at a time, and the arch form was maintained. Incisors were then repositioned using the "auto align" tool and detailing was performed if necessary. Finally, the models in occlusion were evaluated for potential collisions between the teeth with the 'avoid collision" tool, and when necessary, corrections were made (Figure 1B). When ready, the digital setups were saved as digital models, and no further changes were allowed to be made in tooth positions to ensure reliable measurements. Comparisons between digital models in terms of manual setup, digital setup, and final model were carried out by means of linear measurements: intercanine width (ICW) and intermolar width (IMW) and arch length (AL) of the lower dental arch as shown in figure 2. The measurements were performed by a properly calibrated examiner with the aid of specific tool provided by the software.

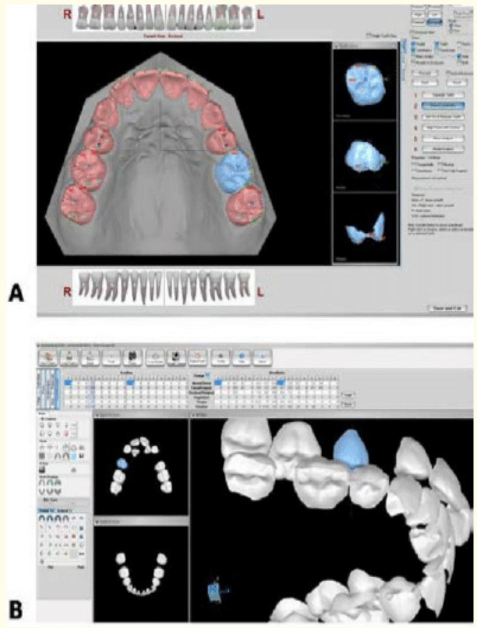

Figure 1: *A) Tooth selection and landmarks definition. B) Occlusion and collision detailing.*

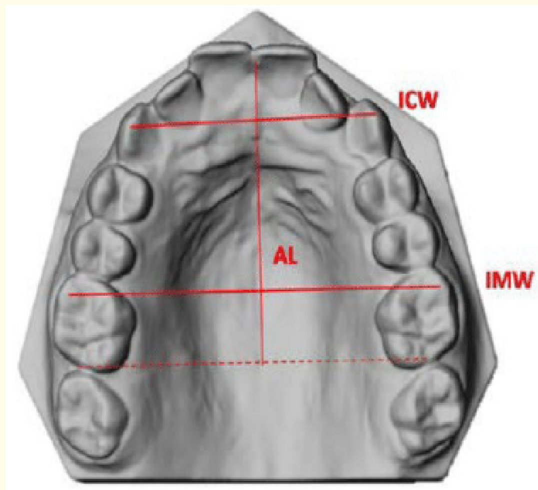

Figure 2: Measurements employed: ICW (Intercanine width), IMW (Intermolar width), AL (Arch length).

Statistical Analysis

Previously, five patients were randomly selected. The digital measurements were performed at two different points in time with 2-week intervals between them, under the same conditions, by a single trained operator. The measured values were subjected to a statistical test to determine random error. For all variables, random error was calculated according to Dahlberg's formula to verify intraexaminer agreement. Analysis of the reproducibility of measurements was performed by testing intraclass correlation, with a confidence level of 95%. For statistical comparisons, data were verified with BioEstat software version 5.0 (Mamirauá Institute, Pará, Brazil). D'Agostino-Pearson test was employed to observe normal data distribution. Moreover, repeated-measures analysis of variance (ANOVA) and Friedman test were used to test the null hypothesis of no difference between the measurements of the setup methods and final models of the patients. The significance level was set at 5%.

Results and Discussion

Systematic error calculation has proven that the method employed showed remarkable reproducibility potential. Correlations for most measurements were rated as outstanding (above 0.83). Results for all measurements are shown in table 1. In analyzing the data, none of the measures assessed with the aid of the manual setup, digital setup, and final models showed any statistically significant differences (P > 0.05). Descriptive statistics and results are shown in table 2.

	Upper arch			Lower arch		
	ICC	Reproducibility	p-value	ICC	Reproducibility	p-value
Inter canine distance	0.96	Excellent	< 0.0001	0.83	Excellent	< 0.0001
Inter molar distance	0.97	Excellent	< 0.0001	0.96	Excellent	< 0.0001
Arch length	0.97	Excellent	< 0.0001	0.99	Excellent	< 0.0001

***Table 1:** Intraclass correlation between measurements.*

	Conventional		Digital		Final		
Upper	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**	**p**
Inter canine distance	35.13	1.2	35.56	1.63	35.68	1.58	0.5467
Inter molar distance	50.22	2.91	49.07	2.34	49.68	2.29	0.5165
Arch length	31.68	2.67	31.33	3.94	32.67	3.38	0.6759
Lower	Mean (mm)	SD	Mean (mm)	SD	Mean (mm)	SD	p
Inter canine distance	27.28	1.75	27.76	1.47	27.57	1.53	0.8933
Inter molar distance	43.95	2.60	43.62	2.13	43.83	1.82	0.5623
Arch length	29.20	3.20	29.01	3.36	29.72	3.39	0.7875

***Table 2:** Descriptive statistics and results of Friedman and Analysis of Variance Tests for conventional setups, digital setups and final models.*

Conventional orthodontic set up consists in occlusion reprogramming using initial plaster models aiming to verify the applicability of one or varied treatment plans. Conventional setup is undoubtedly an important planning tool, however, the mounting technique is methodic and time consuming. Digital revolution has enabled the substitution of conventional plaster models for virtual ones and a variety of advantages has been cited in this process [6]. Virtual models technology has been introduced commercially since the 90´s decade [7], but just recently has received a close attention and studies have certified digital models reliability [8]. According to research published previously [9] the digital models proved as reliable as plaster models casts in obtaining the measures commonly used for diagnosis. Other authors [6] reported that digital models offer a high degree of validity when compared with the direct measurement of plaster models. Authors that reported differences between the physical and virtual approaches have mentioned that discrepancies are likely to be within clinically acceptable limits [10].

Digital data storage has not been the solely tool available. Manufactures have added other working options and the digital setup is definitely a very useful one. Previous study published by the current group has confirmed the reliability of digital setup constructed using the 3Shape® scanner [11], and yet researches aiming to test others commercially available machines are anticipated and as far as the present study could access, no research has been published aiming at evaluating the accuracy of digital setups applying the laser scanner Ortho Insight 3D®.

In the present investigation, the three variables measured did not show any statistical difference (p > 0.05). Intercanine and intermolar distances represented transversal measurements and arch length represented anterior posterior, evidencing that the digital setup showed no relevant distortion. Differences observed were considered tiny and not clinically relevant. The present data suggest that the use of digital teeth reprogramming is a valuable tool for orthodontics planning. It is worth mentioning that the performed digital setup followed strict guidelines and was not constructed artistically to match the objectives of the study. The importance of a meticulous method of fabrication has been highlighted previously [3].

The final model group was included in the study in order to ensure that it is completely viable to reproduce clinically the outcome planned using the setup. The treatments verified in the present study belong to an Orthodontic Post-Graduation Course and followed strictly the guidelines proposed. The final model group confirmed the achievement of the goals and it is believed that the current evidence will encourage clinicians to prepare setups, especially for the complex cases, and to give close attention to the guidelines planned. It is also inferred by the results that professionals can migrate to digital technique, although extensive previous training is recommended. Moreover, despite not having been the object of the present investigation, digital preparation seemed to be more practical and less time consuming when compared to the physical technique, however, well calibrated studies are required for clarification of this matter.

Conclusion

The presented research demonstrate that if properly constructed the digital setup is a viable and useful tool for treatment planning in orthodontics, thus facilitating communication between professional and patients and enabling greater confidence in the application of any orthodontic therapy.

Conflict of Interest

The authors declare no conflict of interest with any of the companies or products used in this study.

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