Journal of Research in Medical and Dental Science
2021, Volume 9, Issue 9, Page No: 122-126

Available Online at: www.jrmds.in
eISSN No.2347-2367: pISSN No.2347-2545

Comparative Assessment of Reliability and Accuracy of Two Different Software's Used for Model Analysis

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ABSTRACT

Aim: The aim of the present study was to assess and compare the reliability and accuracy of two different software's used for measuring arch dimensions and doing model analysis.

Objective: The objective of the present study was to assess the reliability and accuracy of 2 digital softwares for orthodontic model analysis and compare it to manual method.

Background: With emerging technology in the field of dentistry, 3D virtual models are been widely used for diagnostic and research purposes.

Materials and Methods: The study involved pre-treatment study models of 20 patients evaluated by 3 methods namely, Group 1- manual, Group 2 - ExoCad and Group 3 - Ortho Analyser software. Measurements of the following parameters, inter premolar width (IPW), intermolar width (IMW), arch length (AL) and Bolton's ratio (BR) were performed and the data obtained was tabulated and subjected to statistical analysis with SPSS version 23.0. The normality of data was assessed using Shapiro-Wilk test. Reliability among the groups was assessed using Cronbach's alpha test. The differences in the parameters across the 3 groups were assessed using one way ANOVA followed by post hoc Tukey test. A p value < 0.05 was considered statistically significant.

Results: Shapiro wilks test confirmed the normality of the data (p>0.05). The Cronbach's alpha test for reliability of IPW, IMW, AL concluded excellent reliability (>0.9) and for BR a moderate reliability (0.5-0.8) was noted. No significant difference among the groups studied was observed for all parameters (Post hoc Tukey test p> 0.05)

Conclusion: The two softwares used for model analysis are reliable as well as accurate as manual method of model analysis. The linear measurements made on the two softwares are accurate as manual method.

Key words: Anterior fissure, Papilla, Defecation

HOW TO CITE THIS ARTICLE: Harsha L, Ravindra Kumar Jain, Comparative Assessment of Reliability and Accuracy of Two Different Software's Used for Model Analysis, J Res Med Dent Sci, 2021, 9(9): 122-126

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Received: 11/06/2021
Accepted: 09/09/2021

INTRODUCTION

In order to achieve good finishing in Orthodontics, a comprehensive diagnosis and treatment planning should be made. One of the basic diagnostic and treatment planning tools used to determine the degree of obliquity and the incompatibility between the arch shape and tooth dimensions are orthodontic models [1]. These models can be efficiently used for three-dimensional (3D) documentation of the dental arches in pre-treatment, progress, and post-treatment records [2]. Plaster versions, in contrast to other methods of recording treatment data, necessitate a large amount of effort and storage space due to their size and weight [3]. Despite these drawbacks and the possibility of missing or damaged models, plaster models remain the gold standard and favoured approach in clinical and science applications [4,5].

Intra-oral scanners to scan the teeth and underlying tissues are an alternative to plaster models and have been recently introduced in orthodontics [6]. Digital models have several ad-vantages, such as the low storage requirement and rapidly obtained data that can be easily sent to the dentist, laboratory, or the patient [6-8]. Digital models also allow patient-specific virtual "set-up" and advanced treatment planning in both removable and fixed orthodontic appliances [7,8]. A number of digital softwares are now available and are widely used in the field of orthodontics. These include, Ortho analyser, Cadent, ortholab, orthoproof [9], digimodel, ortho CAD [10]. The process of how these digital softwares work for model analysis includes scanning either intraorally or plaster models using a scanner, post which a stereolithographic (STL) file is produced of the scanned model. The STL files are then imported to the supported software onto which measurements can be made.

Comparisons of digital models and plaster models have been made with respect to diagnostic accuracy and measurement sensitivity [10-12]. One of the most commonly assessed parameters is Bolton's analysis. The

Bolton analysis was first used in 1958, with the development of two ratios based on the total of the maxillary and mandibular mesiodistal widths of patients with ideal occlusion [13].

The Bolton analysis informs clinicians of tooth size incompatibility as well as the amount of variance from the ideal arch dimension ratio [13,14]. Other commonly assessed parameters include inter premolar width, inter molar width and arch length.

Since digital softwares is constantly updating, research into the importance of accuracy and reliability needs to be assessed.

Therefore, the purpose of the present study was to assess the reliability and accuracy of measurements made on digital models using two different softwares and compare them with manual method of model analysis.

MATERIALS AND METHOD

20 pre-treatment orthodontic models (upper and lower study models of 10 patients) of subjects reporting to the Department of Orthodontics, Saveetha Dental College and Hospitals, SIMATS for orthodontic treatment in permanent dentition, class1 malocclusion with mild spacing and crowding were included in this study.

The sample size was calculated before conducting the study using G Power. The mean and standard deviation of the parameter, arch length was used to determine the sample size [15]. A sample size of 15 dental models was needed to obtain a statistical power of 95%.

Two softwares namely, ExoCad version 2.4 (Darmstadt, Germany) and Ortho analyzer version 2019 (3Shape, Copenhagen, Denmark) were used for digital model analysis. Manual model analysis was done using a digital calliper (Group 1, N=20).

In order to obtain the digital models, the upper and lower study models of each patient were scanned using the Trios (3Shape, Copenhagen, Denmark) 3D scanner. This scanner operates with a laser beam with 2 cameras to capture the image. The images are automatically processed using the Sewer scan software which generates files with stereolithographic (STL) extension for each model. The STL files obtained post processing were imported for digital measurements to Ortho analyser (Group 2, N=20) ExoCad (Group 3, N=20). ExoCad software is used in prosthodontics, restorative and implant dentistry while Ortho analyzer is an exclusive software used in Orthodontics.

Four Parameters, interpremolar width, intermolar width, arch length and overall and anterior Bolton's ratio were measured in all the 3 groups.

The interpremolar arch width (IPW) was taken from the first premolar of the left side to the right side at the distal end of its occlusal groove. The molar arch width (IMW) was taken from the maxillary left first permanent molar to the same of the right at its mesial pit on the occlusal surface [16].

Arch length was measured from the mesial marginal ridge of the 1st molar to the mesial marginal ridge of the opposite 1st molar [17] using a brass wire manually and the digital measurement was made on the software.

The anterior and overall Bolton ratios were calculated by dividing the total of the widths of the maxillary teeth by the total of the widths of the mandibular teeth [13]. The distances were measured in millimetres (mm) in both manual and digital methods.

RESULTS OF STATISTICAL ANALYSIS

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 23.0 software (IBM Corp.; Armonk, NY, USA). Normality of the obtained data was assessed using the Shapiro-Wilk test. The results of the Shapiro-Wilk test are mentioned in table 1. To assess the accuracy of the parameters assessed across and between the 3 groups, one way ANOVA was done followed by post hoc Tukey test.

The mean, standard deviations and p value of ANOVA are mentioned in Tables 2 and 3. Value of $p<0.05$ was considered as statistically significant. The p values of to assess the reliability of the 3 methods of model analysis, Cronbach's alpha test was done and the p values are mentioned in Table 4. A value 0.9 indicates excellent reliability.

Table 1: Shapiro-Wilk normality distribution test for all parameters included (p>0.05 indicates normal distribution).

Parameters assessed	Sig p value
Inter premolar width	0.41
Inter molar width	0.64
Arch length	0.44
Overall Bolton's ration	0.59
Anterior Bolton's ratio	0.61

Table 2: The mean, standard deviations and ANOVA p value of the 5 parameters assessed among the 3 groups.

	Group 1 (mm)	Group 2 (mm)	Group 3 (mm)	ANOVA SIG p value
Inter Premolar Width	32.56 ± 3.97	33.39 ± 4.03	33.63 ± 3.96	0.67
Inter Molar Width	41.07 ± 4.93	41.61 ± 4.76	41.89 ± 4.64	0.85
Arch Length	76.46 ± 8.74	78.55 ± 8.23	77.77 ± 7.83	0.55
Overall Bolton's Ratio	90.51 ± 2.17	90.22 ± 3.29	91.14 ± 1.92	0.33
Anterior Bolton's Ratio	76.37 ± 2.84	75.52 ± 2.3	78.15 ± 3.6	0.64

Table 3: Post hoc Tukey test for intergroup comparison. p value <0.05 was considered statistically significant.

Parameters Assessed	Compared Groups	Sig P Value
Inter premolar width	Manual vs. Ortho analyser	0.78
	Manual vs. ExoCad	0.67
	Ortho analyser vs. ExoCad	0.98
Inter molar width	Manual vs. Ortho analyser	0.93
	Manual vs. ExoCad	0.85
	Ortho analyser vs. ExoCad	0.98
Arch length	Manual vs. Ortho analyser	0.55
	Manual vs. ExoCad	0.70
	Ortho analyser vs. ExoCad	0.96
Overall boltons ratio	Manual vs. Ortho analyser	0.96
	Manual vs. ExoCad	0.84
	Ortho analyser vs. ExoCad	0.74
Anterior boltons ratio	Manual vs. Ortho analyser	0.82
	Manual vs. ExoCad	0.43
	Ortho analyser vs. ExoCad	0.93

Table 4: Cronbach's alpha value for inter group reliability assessment for all the parameters included. Value >0.9 indicates excellent reliability.

Parameters assessed	Cronbach's alpha value
Inter premolar width	0.99
Inter molar width	0.99
Arch length	0.97
Overall Bolton's ratio	0.82
Anterior Bolton ratio	0.65

DISCUSSION

The present study involved assessment of accuracy and reliability of ExoCad and Ortho analyzer software for performing digital model analysis. The various parameters assessed among the 3 groups when subjected to statistical analysis reported no significant difference (ANOVA test p value>0.05). The differences between the individual groups assessed for the studied parameters also were not significant (post hoc Tukey test p>0.05). The reliability of interpremolar width, intermolar width and arch length was excellent (>0.9) and moderate for overall and anterior Bolton's ratio (0.5-0.8) among the 3 groups when assessed using Cronbach's alpha test.

The accuracy and reliability of plaster models and digital models have been compared previously but none of them have reported comparison of Exocad and Ortho Analyzer software with manual method of model analysis. Majority of the studies have reported indirect scanning method to generate digital models similar to our study [3,6,11,18-25] and only a few studies have used a direct

intra oral scan [19,26]. In the present study indirect scanning was used as it reported that if the plaster models were obtained within 1 hour of the alginate impression, a deviation of 1.285% from the digital model obtained from direct scanning is noted and this was not significant [27].

The use of 3D digital models in dentistry has grown steadily and there is a availability of many different types of scanners. However, only a few studies that compared the conventional with the digital model analysis method have used 3D scanner and an analysis software program of the same manufacturer [11,20,22-24]. Several studies have used model analysis software not provided by the manufacturer of the scanner used [3,6,11,18-20,25,26]. In the current study, the use of the 3Shape scanning system with integral Ortho Analyser software allowed an analysis of digital models obtained with a continuous 3D scan system. The accuracy of this scanner has been listed as 15 microns by the manufacturer. However, previous studies have shown this value to be 25–45 microns [28,29]. Furthermore, there was no loss of data or time during the calibration and orientation of 3D images.

When performing measurements on digital or plaster models, the operator's reliability is crucial. There can be data loss or deviation because of the learning curve for performing digital and plaster model measurements [30]. To reduce these variations to minimum, the measurements of each model were performed two times by a single operator, and the arithmetic average of these measurements was used in the evaluations.

Several studies in the literature have evaluated plaster and digital models with respect to validity and reliability. Some of them have reported a statistical difference [20], but some have reported no clinically significant difference also [18,21]. In studies that have found a statistical difference between the two methods, the greatest difference was reported to be 1.48 mm [31]. Profitt et al. [1] reported that a difference of <1.50 mm in the model analysis was not clinically significant. Hence the results of the current study support the findings of previous studies mentioned above.

Some previous studies that have compared Bolton anterior and overall ratios in digital and plaster models have found statistically significant differences. There are studies that have reported a statistically significant difference in the Bolton analysis, however, the mean difference in these studies of 0.05–1.2 mm was not reported as clinically significant (3)(19)(20)(22)(31). The data obtained in the current study were similar, with no statistically or clinically significant difference determined in the Bolton analysis.

In Terms of reliability assessment of manual and digital software for model analysis, all parameters included show moderate to excellent reliability. This again proves that digital models are as reliable as manual models for model analysis and can be used.

One of the limitations of the study was that the speed of the digital software program may vary, depending on the version and different hardware specifications. Digital methods and analysis programs are constantly updated and accelerated. Because of this fact, further studies should be carried out taking into account the deficiencies of our study.

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