ORIGINAL RESEARCH

Accuracy and Precision in Dental Measurements: A Comparative Study of Digital and Manual Techniques

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ABSTRACT

Background: The orthodontic diagnosis, as in any other dental specialty, is a main element in establishing and specifying the goals of correct treatment. Intraoral impressions have been widely employed in the field of dentistry, and they still remain an area of crucial interest amongst dentists. The present study was conducted for comparing the accuracy of digital and manual method of dental measurements

Materials & methods: The present study was conducted for comparing the accuracy of digital and manual method of dental measurements. A total of 20 subjects were enrolled in the present study. All the subjects belonged to the age range of 20 to 25 years. Only those subjects were enrolled which had full complement of permanent maxillary teeth from the first molar to contralateral first molar. Dental measurements were taken intraorally with the help of a digital vernier caliper. The data collected through this methodology were designated as the control group. An elastomeric impression material, specifically condensation silicone putty, was employed to capture the intraoral impression, which was subsequently poured with type IV die stone without delay. The physical models were measured using a digital vernier caliper. For the digital impressions, the dentitions of the subjects were scanned utilizing an intraoral scanner, commencing with the first quadrant and progressing sequentially through the second, third, and fourth quadrants. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis.

Results: Mean mesiodistal width of CI among control group, physical models and virtual models was 8.65, 8.61 and 8.62 respectively. Mean height of canine among control group, physical models and virtual models was 35.31, 35.29 and 35.28 respectively. Mean inter-canine width among control group, physical models and virtual models was 53.13, 53.08 and 53.11 respectively. While comparing the MD width of CI, Height of Canine, Inter-canine width, Inter-molar width, Anterior arch length and Total arch length among different study groups, non-significant results were obtained.

Conclusion: The research demonstrates that digital models may serve as a viable alternative to traditional plaster models, exhibiting a level of accuracy and reliability that is comparable to that of the conventional method.

Key words: Digital, Manual, Dental

INTRODUCTION

The orthodontic diagnosis, as in any other dental specialty, is a main element in establishing and specifying the goals of correct treatment.[1] Knowing, recognizing, and defining the relationships between skeletal, dental, facial, and functional problems play a fundamental role in specifying individual characteristics and in ordering priority in the treatment plan.[2]

Plaster models are used to improve the orthodontic diagnosis. Specifically, they are used to visualize the morphology and position of the teeth in their respective dental arches, as well as to provide a 3-dimensional model of the patient's occlusion. Traditional plaster models have a long history as diagnostic materials, but they present some drawbacks such as space problems and/or the risk of rupture as a result of the nature of the materials with which they are made.[3,4]

Digitization of the models offers the orthodontist an alternative to study them, because it allows evaluation of the sagittal, vertical, and horizontal planes with an almost real approximation.[5,6] There are currently 3 methods of reproducing digital orthodontic study models: laser scanning of plaster models or impressions; cone beam computed tomography (CBCT) of orthodontic impressions or plaster models; and intraoral laser scanning of dental arches or scans of plaster models in the office.[7]

Since the latter half of the eighteenth century, intraoral impressions have been widely employed in the field of dentistry, and they still remain an area of crucial interest amongst dentists. Evolutionary changes over a couple of centuries have been observed in relation to the techniques of making dental impressions that are inclusive of molded wax, compounds, reversible and irreversible hydrocolloids, and synthetic rubbers. Intraoral impressions are fundamental to a plethora of procedures including therapeutic planning, diagnostics, patient communications, cast fabrications, and preparing restorations.[8-11] This study was conducted to compare the digital and manual dental measurements.

MATERIALS & METHODS

The present study was conducted for comparing the accuracy of digital and manual method of dental measurements. A total of 20 subjects were enrolled in the present study. All the subjects belonged to the age range of 20 to 25 years. Only those subjects were enrolled which had full complement of permanent maxillary teeth from the first molar to contralateral first molar. Dental measurements were taken intraorally with the help of a digital vernier caliper. The data collected through this methodology were designated as the control group. An elastomeric impression material, specifically condensation silicone putty, was employed to capture the intraoral impression, which was subsequently poured with type IV die stone without delay. The physical models were measured using a digital vernier caliper. For the digital impressions, the dentitions of the subjects were scanned utilizing an intraoral scanner, commencing with the first quadrant and progressing sequentially through the second, third, and fourth quadrants. The measurements recorded included: (1) tooth width, specifically the mesio-distal (MD) width of the central incisor (CI), representing the maximum mesiodistal diameter of the tooth; (2) tooth height, defined as the canine height (measured from the gingival zenith to the cusp tip); (3) arch width, which encompassed inter-canine width (the distance between the cusp tips of opposing canines) and inter-molar width (the distance between the mesio-buccal cusp tips of opposing first molars); (4) arch length, measured from midline to the first premolar (from midline to the buccal cusp tip of the first premolar) and from midline to the first molar (from midline to the mesio-buccal cusp tip of the first molar). The measurements were subsequently subjected to statistical analysis to evaluate the accuracy of the data derived from both the physical and virtual models of the control group. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis.

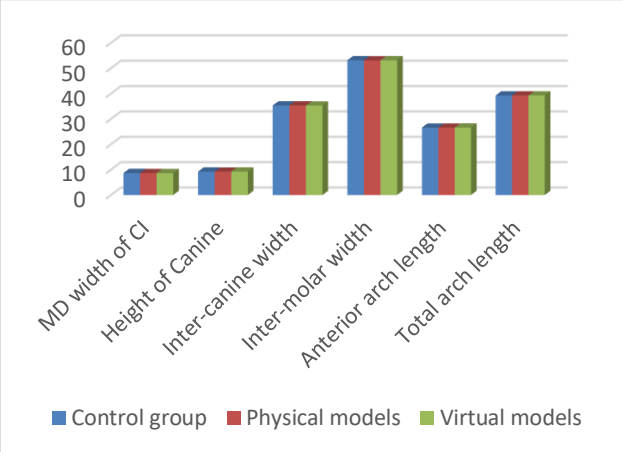
RESULTS

A total of 20 subjects were enrolled in the present study. All the subjects belonged to the age range of 20 to 25 years. Mean age was 23.9 years. Mean mesiodistal width of CI among control group, physical models and virtual models was 8.65, 8.61 and 8.62 respectively. Mean height of canine among control group, physical models and virtual models was 35.31, 35.29 and 35.28 respectively. Mean inter-canine width among control group, physical models and virtual models was 53.13, 53.08 and 53.11 respectively. While comparing the MD width of CI, Height of Canine, Inter-canine width, Inter-molar width, Anterior arch length and Total arch length among different study groups, non-significant results were obtained.

Table 1: Comparison of dental measurements

Variable	Control group	Physical models	Virtual models	p-value
MD width of CI	8.65	8.61	8.62	0.13
Height of Canine	9.23	9.21	9.24	0.25
Inter-canine width	35.31	35.29	35.28	0.81
Inter-molar width	53.13	53.08	53.11	0.61
Anterior arch length	26.56	26.55	26.58	0.27
Total arch length	39.23	39.25	39.25	0.97

Graph 1: Comparison of dental measurements



DISCUSSION

Dental models are an indispensable diagnostic and legal tool for all dental disciplines regarding the processes for training future dentists. They may also be used as a documentary tool, working well as a duplicate model. Furthermore, plaster models are valued by the academic community for their use in evaluating patient progress and documenting research.[12,13]

Traditionally, dental models are made in the laboratory using gypsum products with different levels of hardness, depending on the model's purpose. These are obtained from dental arch impressions—which are recorded using elastic materials or intraoral scanners—producing positive images of a patient's teeth and the surrounding tissue, which must be reproduced as accurately as possible. Intraoral scanners are becoming more and more common, but little is known about their accuracy for full-arch scans, despite their increasing use in daily life.[14,15] The accuracy of a scan is affected by intraoral conditions, such as the optical digitalization unit's restricted area, possible fogging of the digitalization unit, the patient's and dentist's movements, intraoral light, the presence of humidity (saliva or blood), the soft tissue, or the optical scanning equipment used (scanning wands).[16] Traditional stone dental models have notable advantages, including their affordability, simplicity of use, accuracy in details impression reproduction, compatibility with impression materials, dimensional stability, and great mechanical properties. The disadvantages of using them include the need for additional storage space and the risk of fracture and deterioration.[17]

A total of 20 subjects were enrolled in the present study. All the subjects belonged to the age range of 20 to 25 years. Mean age was 23.9 years. Mean mesiodistal width of CI among control group, physical models and virtual models was 8.65, 8.61 and 8.62 respectively. Mean height of canine among control group, physical models and virtual models was 35.31, 35.29 and 35.28 respectively. Mean inter-canine width among control group, physical models and virtual models was 53.13, 53.08 and 53.11 respectively. Jiménez-Gayosso SI et al[18] compared the differences between the measurements performed manually to those obtained using a digital model scanner of patients with orthodontic treatment. A cross-sectional study was performed in a sample of 30 study models from patients with permanent dentition. For the digital measurement, a Maestro 3D Ortho Studio scanner (Italy) was used and Mitutoyo electronic Vernier calipers (Kawasaki, Japan) were used for manual measurement. The outcome variables were the measurements for maxillary intercanine width, mandibular intercanine width, maxillary intermolar width, mandibular intermolar width, overjet, overbite, maxillary arch perimeter, mandibular arch perimeter, and palate height. The independent variables, besides age and sex, were a series of arc characteristics. Two of nine measurements for pre-treatment and 6 of 9 measurements for post-treatment showed a difference. The variables that were different between the manual and digital measurements in the pre-treatment were maxillary intermolar width and palate height ($P<.05$). Post-treatment, differences were found in mandibular intercanine width, palate height, overjet, overbite, and maxillary and mandibular arch perimeter ($P<.05$). The models measured manually and digitally showed certain similarities for both vertical and transverse measurements. There are many advantages offered to the orthodontist, such as easy storage; savings in time and space; facilitating the reproducibility of information; and conferring the security of not deteriorating over time. Its main disadvantage is the cost.[18]

In the present study, while comparing the MD width of CI, Height of Canine, Inter-canine width, Inter-molar width, Anterior arch length and Total arch length among different study groups, non-significant results were obtained. Thakkar H et al determined and compared the accuracy of dental measurements calculated on physical and digital models with the measurements taken directly from the patients' mouth. This study was performed on 40 subjects. Forty maxillary impressions were produced using a condensation silicone putty material and constructed into a physical model. A digital vernier caliper was utilized to take direct measurements from the patients' mouth as well as from the physical models. CS 3600 was employed for direct intra-oral scanning for the subjects' dentition and generating the digital model. There were no statistically significant differences between the physical and virtual models as compared to those measurements taken directly from the mouth. The results of the study demonstrated that intraoral scans are clinically sound to be used in diagnosis and treatment planning in dentistry and provide a professional and well-grounded substitute to the use of conventional plaster models.[19]

CONCLUSION

The research demonstrates that digital models may serve as a viable alternative to traditional plaster models, exhibiting a level of accuracy and reliability that is comparable to that of the conventional method.

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