DOI: 10.7860/JCDR/2023/59169.17516

Original Article

Dentistry Section

Comparative Evaluation of Accuracy of Reconstructed 3D Printed Rapid Prototyping Models and Conventional Stone Models with Different Ranges of Crowding: An In-vitro Study

ANKITA M MOHITE[1], LALITA G NANJANNAWAR[2], JIWANASHA M AGRAWAL[3], SANGAMESH FULARI[4], SHRADDHA SHETTI[5], VISHWAL KAGI[6], AMOL SHIRKANDE[7], SANJIVANI GOFANE[8]

ABSTRACT

Introduction: The digitalisation of dental models has made significant contribution to the current success of orthodontic practices. Rapid Prototyping (RP) is an innovative method of producing physical objects based on Computer-Aided Design (CAD) Computer-Aided Manufacturing (CAM).

Aim: To compare the accuracy of the Three-Dimensional (3D) printed rapid prototyped models with orthodontic stone models across different ranges of crowding.

Materials and Methods: An in-vitro study carried out at the Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Sangli, Maharashtra, India during September 2019 to September 2020. A total of 36 rapid prototyped models were reconstructed from stone models using Light Emitting Diode (LED) scanner and Digital Light Processing (DLP) technology. Dental stone models and RP models were evaluated using digital caliper for different linear measurements and arch dimensions. The data was analysed using Statistical Package for Social Sciences (SPSS) version 26.0. To evaluate accuracy, t-test analyses and Bland-Altman plotting were performed.

Results: T-test showed statistically non significant difference in all parameters of measurements of RP models when compared to stone models. According to Bland-Altman plotting. The mean difference between stone and RP models for the various degree of crowding was minimal and within ±0.07 mm in all planes.

Conclusion: Discrepancy between dental plaster models and RP models were less than 0.5 mm which was considered clinically non significant. Suggesting that RP models can be effectively used as an alternative to stone models.

Keywords: Digital orthodontics, Stereolithography, Three-dimensional printing

INTRODUCTION

The incorporation of digital technologies into orthodontic practise has changed diagnosis and treatment planning from a traditional Two-Dimensional (2D) method to an advanced 3D approach [1]. In recent years, improvements in digital imaging and modelling have allowed the creation of a virtual orthodontic patient that offers the 3D reconstruction of bony structure, soft tissue, and dentition [2]. Digital models have a number of advantages, including ease of storage, data retrieval, time saving, cost-effectiveness, transferability, and also improved treatment quality [3].

Institutions have a legal binding to hold the patient records for up to 10 years [4]. The problem of storage space can be handled by scanning and preserving past patient study models in digital format. However, there can be hesitation to dispose off these stone models, as there may be occasions, such as research work requirements or medico-legal circumstances, where tangible records are essential [5].

The 3D printing or RP is a new technology that can create graspable 3D objects directly from digital models, which can address the need for physical models when required [4]. It is among of the most futuristic innovations that can translate a fevered imagination into hard reality. This method is classified as an additive manufacturing, where the physical model is constructed layer by layer, once the digital model has been divided into layers of a specific thickness [4]. This can be achieved through various techniques such as Stereolithography (SLA), Inkjet-based system (3D printing-3DP), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM) and DLP [6].

Any inaccuracy in the printing of working models may cause insufficient tooth movements and have a detrimental effect on treatment outcomes [7]. Few studies have reported acceptable clinical accuracy of RP models in comparison with conventional stone models [3,8]. However, there is scarcity of information regarding impact of crowding on the precision of measurements done on reconstructed RP models. Teeth can overlap in crowded area and it may be more difficult to accurately replicate the undercut sections that are blocked from the sensor's view while scanning. Hence, accuracy and reproducibility of RP models must be carefully evaluated.

The aim of this study was to elucidate whether the tooth measurements recorded on stone models and 3D printed RP models with different ranges of crowding are equivalent and comparable.

MATERIALS AND METHODS

This in-vitro investigation was carried out carried out in the Department of Orthodontics and Dentofacial Orthopaedics at the Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Sangli, Maharashtra, India, from September 2019 to September 2020. On June 20, 2019, the Institutional Ethical Committee accepted the study (Letter number: BVDUMC&H/IEC/Dissertation2018-19/D-02). The procedure of study was followed in conformity with the Institute's ethical standards. Prior to the impression, the volunteer's informed consent was obtained.

Inclusion criteria: The inclusion criteria of study models were completely erupted, permanent teeth from first molar to contra-lateral first molar with mild, moderate, or severe crowding and good surface details.

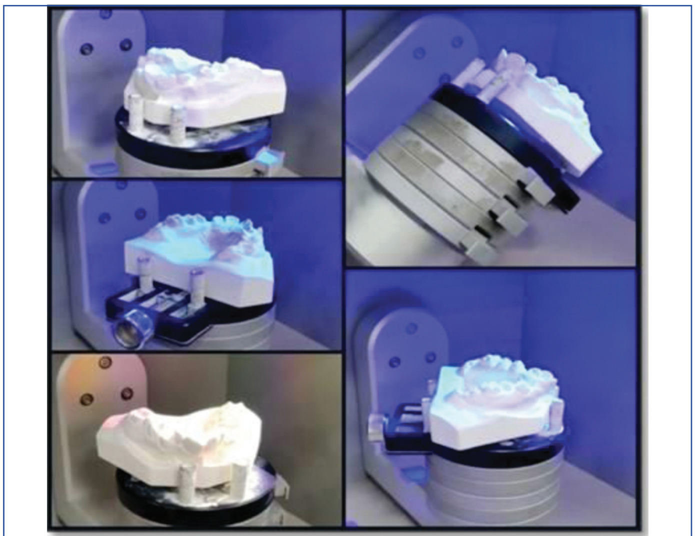
Exclusion criteria: Patients who had undergone or were undergoing orthodontic treatment, as well as those with voids or fractures, aberrant tooth shapes and surfaces, or extra teeth, were eliminated from the study.

Sample size calculation: The sample size was estimated using SPSS Software based on a previous study conducted by Wan Hassan WN et al., [4]. Approximately, 34 samples per group (Dental stone models group and RP models group) were required. To improve the power of the study, the number of models per group was increased to 36 with a difference of 0.15 mm and a standard deviation of 0.22 mm at the 5% level of significance (80% power Type I error to be 5% Type II error to be 20%).

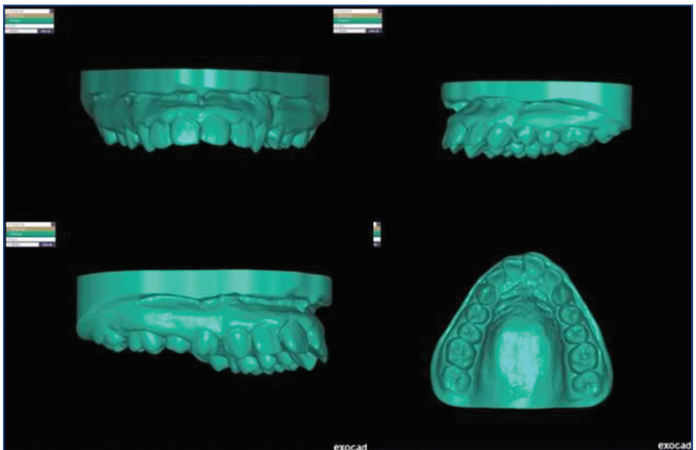
Study Procedure

Impressions were made by using alginate impression material and positive replicas were made by using type III dental stone. A total of 36 dental stone models with crowding were collected. Crowding was calculated by comparing the total mesiodistal breadth of the teeth to the available space in the arch. According to the Proffit WR, crowding was divided into three categories: mild (1-4 mm), moderate (5-8 mm), and severe (>9 mm) [9]. Based on crowding the 36 models were subdivided into three groups of 12 each.

To generate 3D digital models, all dental stone models were scanned by using a Hybrid with Blue LED scanner (MeditIdentica with accuracy of 7 µm) in multiple planes [Table/Fig-1]. Scanned data was saved as Standard Tessellation Language (STL) file [Table/Fig-2]. The data were sliced into individual layers by Mesh-Meshmixer software. Scanned data were uploaded to reconstruct



[Table/Fig-1]: Extra-oral scanning of dental stone models in multiple planes.



[Table/Fig-2]: Standard tessellation language model.

36 RP models with Nextdent 5100 3D System Printer using DLP technology. The printing material comprised of high performance Biobased Acrylate Photocurable Resin (BAPR) [Table/Fig-3].

[Table/Fig-3]: 3D printing process.

A total of 72 models consisting of 36 samples each of dental stone models (Group A) and RP models (Group B) were measured with hand-held digital vernier caliper. Clinically significant parameters, such as tooth size dimensions and arch dimensions, were measured to determine whether the quality of the RP models would be clinically acceptable for linear measurements [Table/Fig-4-6] [4].

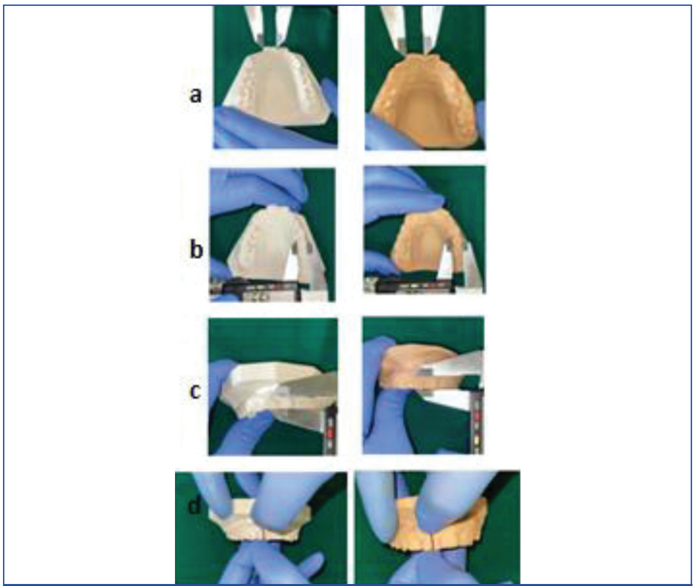
Parameters		Description
Tooth dimensions	Mesiodistal Width (MDW)	The greatest mesiodistal diameter.
	Buccolingual Width (BLW)	Distance between the maximum convexities of the buccal and lingual surfaces.
	Clinical Crown Height (CCH)	Distance along the long axis of tooth between the cusp tip to the cervical line.
	Curvilinear measurements of central incisor	Distance on buccal and lingual surfaces of the maxillary right central incisor along the long axis from the incisal edge to the cervical ridge.
	Curvilinear measurements of first premolar	Distance on buccal and lingual surfaces between the two interdental contact points of first premolar.
Arch Dimensions (AD)	Intercanine Width (ICW)	Distance between the cusp tips of the canines.
	Interpremolar Width (IPW)	Distance between the buccal cusp tips of the contralateral first premolars.
	Intermolar Width (IMW)	Distance between the mesiobuccal cusp tips of the contralateral first molars.
	Arch Length (AL)	Diagonal distance between the mesiobuccal cusp tips of the first molars and the mesial contact areas of the central incisors.
	Arch Perimeter Segments (APS)	Sum of the bilateral arch segments. The first segment is the distance between the distal marginal ridge of the first molar and the mesial contact point of the first premolar; the second segment is the distance from the distal contact point of the canine to the mesial contact point of the central incisor.
	Depth of Palate (DP)	The vertical distance from a point on the palatal width line to the palatal vault in the midline.

[Table/Fig-4]: Definition of various tooth size measurements [4].

Three study model pairings, one from each category, were randomly chosen in order to evaluate operator dependability. Each study model was measured using vernier caliper by the same examiner twice, with an interval of atleast two weeks, to ensure intra-examiner reliability. To determine inter-operator reliability, the first measurements were compared to those acquired by a second examiner using vernier caliper.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS V26.0 at level of significance p≤0.05. All readings obtained were statistically analysed



[Table/Fig-5]: Measurements using the digital caliper on a conventional stone model (Left-side) and a Rapid Prototyping (RP) model (Right-side- Tooth dimensions- a: MDW; b: BLW; c: CCH; d: Curvilinear measurements [4].

[Table/Fig-6]: Measurements using the digital caliper on a conventional stone model (Left-side) and a Rapid Prototyping (RP) model (Right-side)- Arch dimensions- a: ICW; b: IPW; c: IMW; d: AL; and e: IPS; f: Palatal depth.

by calculating their mean, standard deviation and standard error. The Shapiro-Wilk test was used to determine the normality of numerical data, and it was discovered that the data followed a normal curve. As a result, parametric tests have been employed for comparisons. The t-test was used to compare the two groups among themselves. To evaluate the internal consistency and agreement between two or more examiners by using Cronbach's alpha and intraclass correlation (inter and intra). A technique for describing agreement between two quantitative data by creating limits of agreements is the Bland-Altman Plot.

RESULTS

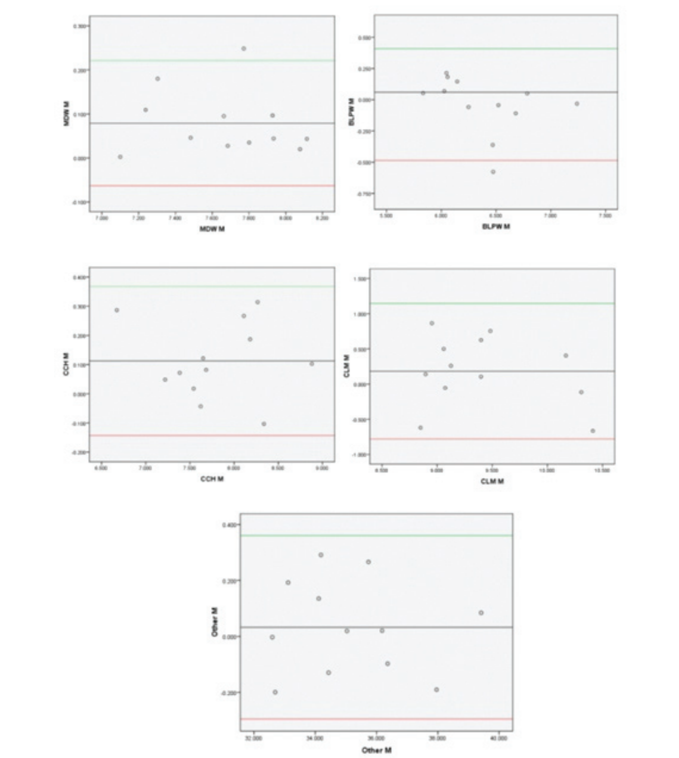
The present study comprised of 12 sets of study models for each category of crowding. The mean systemic differences in all parameters of measurements of RP models when compared to stone models were statistically non significant. Mesiodistal width values of RP models were smaller in moderate crowding (mean 7.71 and 7.63 mm; SD, 0.52 and 0.55 mm). Buccolingual width values of teeth in RP models were smaller than dental stone models with mild and severe crowding whereas, larger in moderate crowding (mean 5.9 and 6.01 mm; SD). In clinical crown height measurements were equivalent in mild and severe crowding (mean 7.64 and 7.55 mm). Curvilinear measurements of buccal and lingual surfaces of central incisor and first premolar in RP models were smaller than dental stone models with mild and severe crowding whereas they were larger in moderate crowding [Table/Fig-7]. Arch dimensions of teeth in RP models were smaller than dental stone models with moderate and severe crowding whereas they were equivalent in mild crowding. The intraoperator ICC values ranged from 0.839 to 0.987 and had an excellent agreement (0.62) [4].

Using the mean and standard deviation of the differences between two measurements, the Bland-Altman Plot was calculated by plotting the data on the XY axis, where the X axis indicates the difference between the two measurements and the Y axis displays the mean of the two measurements. For the different degree of crowding in all planes, the mean bias between stone and RP models was minimal and was within ±0.07 mm [Table/Fig-8].

Planes	Crowding	Mean (Stone model)	Mean (RP model)	Mean difference	SD	Standard error	T-value	p-value
MDW	Mild	8.089	8.031	0.058	0.208	0.118	0.2	0.759
	Moderate	7.743	7.635	0.108	-0.525	0.022	0.381	0.671
	Severe	7.993	7.988	0.005	-0.023	0.01	0.055	0.622
BLW	Mild	6.356	6.395	-0.039	-0.322	-0.381	-0.021	0.619
	Moderate	5.908	6.018	-0.11	-0.25	0.018	-0.46	0.608
	Severe	5.635	5.566	0.068	-0.136	-0.061	0.132	0.714
CCH	Mild	7.526	7.424	0.101	1.315	-0.041	0.11	0.740
	Moderate	7.649	7.565	0.083	-0.05	-0.004	0.254	0.701
	Severe	7.169	7.077	0.091	-0.582	0.054	0.445	0.667
CLM Central incisor	Mild (Buccal)	10.213	10.204	0.009	-0.023	-0.001	0.018	0.986
	Mild (Lingual)	9.707	9.834	-0.127	-0.341	-0.099	-0.256	0.801
	Moderate (Buccal)	10.447	10.233	0.214	-0.053	0.016	0.426	0.674
	Moderate (Lingual)	9.228	9.1	0.128	-0.19	-0.054	0.271	0.789
	Severe (Buccal)	10.297	9.998	0.317	0.396	0.113	0.803	0.431
	Severe (Lingual)	9.339	9.504	0.174	0.133	0.014	0-.610	0.548
CLM Premolar	Mild (Buccal)	9.09	9	0.09	-0.19	-0.055	0.312	0.758
	Mild (Lingual)	10.18	10.04	0.14	-0.01	-0.003	0.414	0.683
	Moderate (Buccal)	9.05	8.89	0.16	-0.206	-0.059	0.593	0.559
	Moderate (Lingual)	9.09	9.78	0.21	-0.201	-0.058	0.600	0.555
	Severe (Buccal)	9.19	9.43	-0.24	-0.191	-0.055	-0.942	0.357
	Severe (Lingual)	10.38	10.36	0.02	-0.133	-0.038	0.093	0.927

AD	Mild	45.253	45.260	-0.007	1.162	0.335	-0.01	0.889
	Moderate	42.201	42.072	0.29	-0.76	0.184	0.1	0.911
	Severe	42.822	42.782	0.04	-0.081	-0.024	0.058	0.902

[Table/Fig-7]: Paired t-test analyses comparing the stone model and Rapid Prototyping (RP) models (Significant if p-value ≤0.05).



[Table/Fig-8]: Bland-Altman plots of measurements made between stone model and Rapid Prototyping (RP) models.

DISCUSSION

This study evaluated the potential use of RP models constructed using 3D printing as an alternative to stone models. The scanning and printing methods are two elements that could impact the calibre of RP models [10]. In present study, MeditIdentica Hybrid with Blue LED scanner was used with three multiplaner cameras and colour-texture support, enabling technicians to form highly digital model. Additionally, scanning into the deep occlusal areas was made possible by Intelligent Multi-View (IMV) technology, providing more precision and information [10-12].

In present study, the models were produced using the 3D printer (Nextdent 5100 3D system printer with DLP technology) with 350 μm accuracy, good surface finishing, and extraordinary high feature resolution (5-50 μm) [13]. The accuracy and truthfulness of dental models created using various 3D printing processes were evaluated by Kim SY et al., [14]. In comparison to the Fused Filament Fabrication (FFF) and SLA procedures, they discovered that the PolyJet and DLP techniques were more accurate.

The printing material used in the present study comprised of high performance composite- BAPR with 0.089 to 0.102 mm thick layers. It has the best mechanical performance of any other biobased resin, with a tensile strength of 7.0 MPa [13]. A significant consideration for the application in a stereolithographic layer-by-layer printing process is the resin's viscosity. Low viscosities are typically preferred to enable adequate recoating of the liquid resin between the last layer of the model and the surface of the resin tank. In comparison to autodesk standard clear prototyping resin, BAPR has a lower viscosity [13].

In the present study, comparison of the various tooth measurements was made on 3D printed models and dental stone models with different degrees of crowding. In all parameters, the results demonstrated that differences were statistically non significant. Similar research on the precision of 3D printed models using various parameters are summarised in [Table/Fig-9] [3,4,14-18].

Stone models have smooth surface and clearly defined interproximal contact points and cervical edges. Insignificant artefacts such as air bubbles and slightly excessive stone materials were observed, however, they were minor and away from the landmarks utilised for measurements. Also, the surfaces of the RP models were coarse

S. No.	Author's name and year	Place of study	Sample size	Objective of study	Conclusion
1.	Kasparova M et al., [3] 2013	Prague	10 (Each group)	To determine whether the dimensions of the plaster models and the RepRap 3D printed models are equal and comparable.	Regardless of the printing technique, there was no statistically significant variation in the accuracy of the buccolingual and mesiodistal width (p-value ≤0.05).
2.	Wan Hassan WN et al., [4], 2017	Malaysia	30 (Each group)	To compare various degrees of crowding between orthodontic stone models and 3D printed RP models.	Reported statistically significant differences in the measurements made in the mesiodistal plane, buccolingual plane and clinical crown height as the contact points between adjacent teeth were slightly thicker in Rapid Prototyping (RP) models and due to expansion in X-Y planes after printing. And statistically non significant difference in measurement made in the arch dimension.
3.	Kim SY et al., [14], 2018	Seoul, Korea	14 (Each group)	To evaluate the accuracy and consistency of dental models produced by 4 different types of 3D printers.	Found significant difference in buccolingual width and clinical crown height showed in mild and severe crowding groups due to inaccuracies in the vertical thickness of the z-plane.
4.	Hazeveld A et al., [15], 2014	Netherlands.	12 (Each group)	To evaluate the precision and reliability of physical models re-created using three distinct methods	Found significant difference in buccolingual width and clinical crown height showed in mild and severe crowding
5.	Keating AP et al., [16] 2008	Cardiff	30 (Each group)	To evaluate the precision of physical model replicas made using 3D digital files.	For some applications, the accuracy of physical models created by printing digital data may not be sufficient using the standard Stereolithography (SLA) techniques.
6.	Sweeney S et al., [17], 2015	Nashville, Tenn.	25 (Each group)	To determine which material is most suited for laser scanning and which most accurately articulates digital models.	Found statistically non significant difference in measurement made in the arch dimension.
7.	Mack S et al., [18], 2017	Houston, Tex.	61 (Each group)	To assess and compare digital dental models with manual measurements along a curved line	Found no significant difference in curvilinear measurements.
8.	Present study	India	34 (Each group)	To compared the various tooth measurements made on 3D printed models and dental stone models with different degrees of crowding.	The results demonstrated that differences were statistically non significant in all parameters.

[Table/Fig-9]: Comparison of present study and previous study [3,4,14-18].

showing flaky appearance. At a crowded area, the clinical impression was less defined and more likely to have a slight surplus of artefacts. The clinical implication of this reduction in detail was not easy to quantify. But such loss in the details may not necessarily be critical for construction of orthodontic appliances, since the shape and size of the teeth and arch form of 3D printing models were similar to the original casts [4]. According to Sweeney S et al., a successful occlusion is defined as an interarch distance with an inaccuracy of less than 0.5 mm (as opposed to the gold standard) [17]. Based on clinical validity and the benchmark established by the American Board of Orthodontics' increments for grading plaster models, the range of error (0.5 mm) was determined [17]. In the present study, the mean systemic differences were small and statistically non significant, suggesting that RP models might be used interchangeably with dental stone models. For craniofacial surgeries, if discrepancies are within 1.0 mm then they are clinically acceptable [4].

Reconstructed models are becoming more and more useful as a tool for difficult craniofacial case visualisation, diagnosis, and surgery planning. It helps to achieve better-operating results, and provide an opportunity to study and manipulate the bone structures of the patient as required before the actual surgery [19]. RP models of the jaws are used as an aid for the fabrication of distractor to produce osteogenic distraction of the mandibular symphysis [15]. It is also used to produce customised lingual brackets for subsequent investment. RP also act as a valuable tool for preparation of dental socket in autotransplantation cases. In production of Invisalign, RP offers advantages of high accuracy with speed [20]. RP versions have a number of benefits, including being lightweight, durable, highly resistant to abrasion, transportable, and most importantly, the capacity to share digital data [1]. There is a great potential to create physical models on demand from digital data, which would alleviate the strain of the storage space issue.

Limitation(s)

The results of this study, does not specify precision of appliances created using RP models. Further studies need to analyse and focus on precision of these appliances for clinical use. It is also possible to rebuild data for 3D printers directly from other data sources, such as Cone Beam Computed Tomography (CBCT) Computed Tomography (CT) (CBCT) or Computed tomography (CT) scans. However, more research is required on these areas which will emphasis on the accuracy using sources from CBCT or CT scans to rebuild data using RP.

CONCLUSION(S)

In present study, the mean systemic differences in all parameters of measurements of RP models when compared to stone models were statistically non significant. Hence, it can be concluded that RP models can be used as alternative to stone models. It is anticipated that 3D printed objects will become more significant in a variety of orthodontic research areas. This includes the use of technology not only to bring about changes in existing pattern but also to enable new things that were previously impossible.

REFERENCES

[1] Taneva E, Kusnoto B, Evans CA. 3D scanning, imaging, and printing in orthodontics. Issues in Contemporary Orthodontics. 2015;148(5):862-67.

[2] Fleming PS, Marinho V, Johal A. Orthodontic measurements on digital study models compared with plaster models: A systematic review. Orthodo Craniofac Res. 2011;14(1):01-06.

[3] Kasparova M, Grafova L, Dvorak P, Dostalova T, Prochazka A, Eliasova H, et al. Possibility of reconstruction of dental plaster cast from 3D digital study models. Biomed Eng Online. 2013;12:49.

[4] Wan Hassan WN, Yusoff Y, Mardi NA. Comparison of reconstructed rapid prototyping models produced by 3-dimensional printing and conventional stone models with different degrees of crowding. Am J Orthod Dentofacial Orthop. 2017;151(1):209-18. Doi: 10.1016/j.ajodo.2016.08.019. PMID: 28024776.

[5] McGuinness NJ, Stephens CD. Storage of orthodontic study models in hospital units in the U.K. Br J Orthod. 1992;19(3):227-32. Doi: 10.1179/bjo.19.3.227. PMID: 1390579.

[6] Zocchi G. New developments in 3D printing of composites: Photocurable resins for UV-assisted processes 2016.

[7] Bartkowiak T, Walkowiak-Śliziuk A. 3D printing technology in orthodontics-review of current applications. Journal of Stomatology. 2018;71(4):356-64.

[8] Sohmura T, Kojima T, Wakabayashi K, Takahashi J. Use of an ultrahigh-speed laser scanner for constructing three-dimensional shapes of dentition and occlusion. J Prosthet Dent. 2000;84(3):345-52. Doi: 10.1067/mpr.2000.109786. PMID: 11005909.

[9] Proffit WR, Fields HW, Larson B, Sarver DM. Contemporary orthodontics-e-book. Elsevier Health Sciences; 2018 Aug 6.

[10] Kim MK, Kim JM, Lee YM, Lim YJ, Lee SP. The effect of scanning distance on the accuracy of intra-oral scanners used in dentistry. Clin Anat. 2019;32(3):430-38. Doi: 10.1002/ca.23334. Epub 2019 Feb 5. PMID: 30663815.

[11] Ender A, Mehl A. Accuracy of complete-arch dental impressions: A new method of measuring trueness and precision. J Prosthet Dent. 2013;109(2):121-28.

[12] Flügge TV, Schlager S, Nelson K, Nahles S, Metzger MC. Precision of intraoral digital dental impressions with iTero and extraoral digitisation with the iTero and a model scanner. Am J Orthod Dentofacial Orthop. 2013;144(3):471-78.

[13] Voet VSD, Strating T, Schnelting GHM, Dijkstra P, Tietema M, Xu J, et al. Biobased acrylate photocurable resin formulation for stereolithography 3D printing. Acs Omega. 2018;3(2):1403-08.

[14] Kim SY, Shin YS, Jung HD, Hwang CJ, Baik HS, Cha JY. Precision and trueness of dental models manufactured with different 3-dimensional printing techniques. Am J Orthod Dentofacial Orthop. 2018;153(1):144-53.

[15] Hazeveld A, Slater JJ, Ren Y. Accuracy and reproducibility of dental replica models reconstructed by different rapid prototyping techniques. Am J Orthod Dentofacial Orthop. 2014;145(1):108-15.

[16] Keating AP, Knox J, Bibb R, Zhurov AI. A comparison of plaster, digital and reconstructed study model accuracy. Journal of Orthodontics. 2008;35(3):191-201.

[17] Sweeney S, Smith DK, Messersmith M. Comparison of 5 types of interocclusal recording materials on the accuracy of articulation of digital models. Am J Orthod Dentofacial Orthop. 2015;148(2):245-52.

[18] Mack S, Bonilla T, English JD, Cozad B, Akyalcin S. Accuracy of 3-dimensional curvilinear measurements on digital models with intraoral scanners. Am J Orthod Dentofacial Orthop. 2017;152(3):420-25.

[19] Mahamood S, Khader MA, Ali H. Applications of 3-D printing in orthodontics: A review. International Journal of Scientific Study. 2016;3(11):267-70.

[20] Wang S, Li M, Yang H, Liu Y, Sun Y. Application of computer aided design and fused deposition modeling technology in the digital manufacture of orthodontic study models. Biomed Res. 2017;28(8):0970-38X.

PARTICULARS OF CONTRIBUTORS:

1. Postgraduate, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
2. Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
3. Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
4. Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
5. Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
6. Assistant Professor, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
7. Assistant Professor, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.
8. Postgraduate, Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Deemed To Be University, Sangli, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Ankita M Mohite,
Flat No. 503, Yashaswi Co. Op. Hos. Soc., Govind Bachaji Road, Charai,
Thane (W), Maharashtra, India.
E-mail: ankimohite94@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 17, 2022
- Manual Googling: Oct 31, 2022
- iThenticate Software: Dec 21, 2022 (14%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: Aug 16, 2022
Date of Peer Review: Oct 29, 2022
Date of Acceptance: Dec 22, 2022
Date of Publishing: Mar 01, 2023