International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Accuracy and Reliabilty of Digital Models in Measuring Little's Irregularity Index

Nivethigaa.B, Saravana Pandian

Abstract: ***AIM: This study evaluated the accuracy of dental measurements made on plaster models compared with blue cam images and digital photographs. MATERIALS AND METHODS: The study sample comprised pre-treatment diagnostic study models of 10 randomly selected subjects divided into three subcategories. CAD CAM and photo graphs of the model were taken and digitally analysed. Plaster models were analysed with a vernier caliper results were obtained. ANOVA test was done to determine the statistical significance. RESULTS: The dental measurements made on the two newer methods of study model analysis(FACAD and Blue-cam Generated digital models), compared to the conventional technique of direct measurement on plaster model using digital Vernier caliper, although revealed slight variations in numerical values, did not show statistically significant difference in any of the twelve dental parameters measured. CONCLUSION: Digital measurement using photographs in FACAD and Blue CAM generated digital models can be used as an alternative to the conventional measurement of plaster models using a vernier caliper.***

Keywords: Blue cam,little's index, digital models

1. Introduction

Diagnosis is the essential process that constitutes to be a link between clinical examination and treatment process. Based on the direct clinical examination a clinician usually arrives at a tentative diagnosis. But this cannot be solely considered for treatment planning process. Hence in order to arrive at a final diagnosis need arises for various supporting diagnostic aids. These diagnostic aids usually simulate the patient's dentition; give an idea about various features like the skeletal hard tissues and association between various structures in various malocclusions and facial deformity [1].

Apart from providing evidence for diagnosis, they also provide tool for differential diagnosis helping us diagnose various rare conditions.

Growth related changes are difficult to assess directly from clinical examination since it doesn't provide exact amount of changes that occur in each component of face at particular age. Hence in such cases it is mandatory to obtain records at various time intervals and to check out the normalcy in growth of various structures and also to determine if any abnormalities exist and also it is very essential to plan for the exact treatment needed at that particular age. Most essential is utilizing growth by using various growth modifying appliances. Hand wrist x-rays especially MP3 radiographs provide a very valuable tool in this aspect as they are better correlated with skeletal maturation and amount of growth that is left for any treatment to be carried out. [2]

Diagnostic records most commonly used since 1930's include photographs, models, lateral cephalogram, hand wrist radiographs, OPG. All these diagnostic records provide a very essential tool in diagnosing a case [3] [4].

With the development in various fields of technology there is transition into more digital form. This also applies to the dental diagnostic tools. Digital systems are far better than the conventional modalities in many ways the essential one being more sophisticated means of communication among the colleagues [5].

Digital photography is the first tool of digital imaging apart from the conventional photos. There is no need for any film or processing. They provide better tool in comparison of several stages photographs. Intra oral and extra oral photographs can be visualized for better diagnosis. They can be electronically stored so that they don't require any extra space like conventional photos. There is very little chance for physical damage. Communication is better with digital imaging systems since they be easily transferred electronically.

Major disadvantage with the digital photographs include the cost, they don't help in medico legal issues since they can be easily morphed [5]

Digital radiography is the next advancement that has provided a better quality improvement in the field of radiographic diagnosis. It is now available for all body parts where any severe or rare condition can be easily diagnosed and treatment progress can be noted. They are instantly obtained unlike conventional radiographs which require special sensors and processing time. They also have a reduced exposure time compared to conventional systems. Effects in the radiographic images like change in brightness, contrast and saturation can be made whenever required. In digital radiography there is software that can be used to locate various cephalometric points. This reduces the working time required for tracing and analysing each radiograph [5].

The dental plaster model is the physical three - dimensional representation of the dentition and oral anatomy that the orthodontist can hold in their hands and view in all three planes of space. In addition to its role as a record for diagnosis and treatment planning, the dental plaster model is routinely used as the positive replica for the fabrication of oral appliances. With the physical dental model, clinicians have been able to perform measurements for various model analyses; to obtain the Kesling setup to decide on extraction or non-extraction treatment philosophy and to compare the treatment outcomes by using the pre-treatment and post treatment study models [6].

A key process in diagnosis and treatment planning in dentistry is the study model analysis which helps the orthodontist in deciding the treatment plan. Hence, accuracy of study models is of utmost importance to an orthodontist. The current gold standard for study model analysis involves plaster casts measured with callipers [7]

However, some of the disadvantages inherent in the use of plaster casts are their weight and volume, time spent on their fabrication, the need for a physical storage space, the risk of breakage and difficulty in exchanging information with other professionals [8][9].

Hence, electronic storage of patient information, including study models, eliminates problems of physical storage, retrieval, maintenance, and office management including documentation of treatment progress and communication between professional colleagues [10][11]. Hence, 3D digital dental models could offer distinct technologic and clinical application advantages over physical plaster models.

There are various methods of obtaining a study model. The conventional methods of obtaining the study models include the use of hydrocolloid impression materials such as alginate or elastomeric impression material such as Polyvinylsiloxane to obtain a negative replica of the patient's dental arch, which is poured using dental plaster to obtain a positive replica. Alternatives to using plaster study models have been suggested ranging from two dimensional digital models such as, occlusogram [12] photocopies of study models [13], photograph of study models [14] and 3 dimensional digital models obtained by holography [15] [16], stereophotogrammetry [17] and stereolithographic models.

For the acquisition of digital images of teeth, different procedures have been described: digitization of plaster casts [18] [18] [19] [20] [21] [22] [23] [24], digitization of impressions [25] and intraoral digital impressions [26] Digital Dental Technology (DDT) for fabrication of dental restorations including computer-aided design/computer-assisted manufacturing (CAD/CAM) has been in development since the 1980s. Its rapid expansion and incorporation into the field of dentistry has been documented since the beginning of 1990s. CEREC Blue-cam connected to CEREC AC unit, introduced by Sirona dental systems, is one such method of acquiring the digital image of dentition. It was originally introduced for the purpose of producing CAD-CAM restorations as a chair side procedure, but can also be used for the purpose of digital archiving of study models. CEREC Blue-cam requires application of a contrasting medium, CEREC Optispray on the surface of dentition, prior to imaging.

In addition to the above mentioned methods to obtain a study model, Cone Beam Computed Tomography (CBCT) can also be used to obtain a detailed view of the patient's dentition as well as internal anatomy of the maxillary and mandibular bones and airway. Past studies have analyzed CBCT accuracy of craniofacial landmarks and determined that measurements were statistically significantly different from measurements taken with a digital calliper but still clinically acceptable (90% of mean differences 2.00 mm) [27]

Studies comparing CBCT to photostimulable phosphor plate imaging have concluded that CBCT is more accurate [28] and more reliable [29]. Despite the increasing adoption of this technology in the field of dentistry, its current role in orthodontic field is limited to the diagnostics tool in assessment of unerupted tooth position, supernumerary teeth, and other certain circumstances [30]. Now, study model analysis can also be performed directly on radiographs, such as CBCT scans, without the need for impressions [31].

The aim of this study is to compare the accuracy and reliability of dental measurements using digital photograph of models, Blue-Cam generated digital models of casts when compared to plaster models.

2. Material and Methods

The study comprised of pre-treatment models of 10 randomly selected patients divided into three subcategories.

The sample was selected from the initial patient records at the Saveetha dental college.
Each subject was in the permanent dentition in the lower arch with first molar to first molar without orthodontic appliances. Subjects with crowding in the lower anterior tooth region were selected. Subjects within the age group of 15-30 years, belonging to both sexes were chosen. Subjects with age < 15 years and > 30 years and who have already undergone orthodontic prosthodontic treatment and present with crown or prosthesis that can affect linear measurements. Patients presenting with missing tooth/teeth, mainly canines, laterals and central incisors. Patients presenting with gross maxillofacial deformity (CL/CP) and pregnant women.

The three subgroups included
Group 1: Plaster model obtained mandibular dentition
Group 2: Photograph of the model
Group 3: Blue-Cam generated digital image of the model

Five dental measurements were obtained from the plaster models using digital vernier calliper from digital photographs using the proprietary software of FACAD and from the Blue-Cam generated digital image using the proprietary software of Sirona Dental Systems Ltd. (CEREC software version 4.1).

The data was tabulated using Microsoft Excel 2009 spreadsheet followed by statistical analysis using Statistical Package for the Social Sciences software (SPSS software version 17) To assess intra examiner reliability, records were re-assessed and the dental measurements were made on all the 30 records, twice by the same examiner at 1 week interval (T1 and T2).

Intra class Correlation Coefficient, was used to compute correlation for the little's index measured at two different times, by the same examiner, in Group 1, Group 2 and Group 3 separately

3. Results

The descriptive statistics for dental measurements made on plaster models, digital photographs and Blue-cam Generated digital models, for each of the parameters measured. The mean irregularity index value with plaster models were 7.6±2.8 and in the digital measurement with FACAD mean value was 8.3±3.1 and with blue cam group the mean value was 7.9±3.

ANOVA test was performed to determine the significance of the study values.

However, there was minimal/no difference in this parameter when it is measured by using any of the 2 digital formats used in the study (P=1) .The results were not statistically significant.

The dental measurements made on the two newer methods of study model analysis(FACAD and Blue-cam Generated digital models), compared to the conventional technique of direct measurement on plaster model using digital Vernier calliper, although revealed slight variations in numerical values, did not show statistically significant difference in any of the twelve dental parameters measured

Descriptives

LITTLEINDEX

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Plaster models	10	7.6800	2.80864	.88817	5.6708	9.6892	4.00	13.90
CAD CAM	10	7.9200	3.09185	.97773	5.7082	10.1318	3.00	13.70
Photographs	10	8.3400	3.13836	.99244	6.0949	10.5851	4.20	14.60
Total	30	7.9800	2.92379	.53381	6.8882	9.0718	3.00	14.60

ANOVA

LITTLEINDEX

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.232	2	1.116	.123	.885
Within Groups	245.676	27	9.099		
Total	247.908	29			

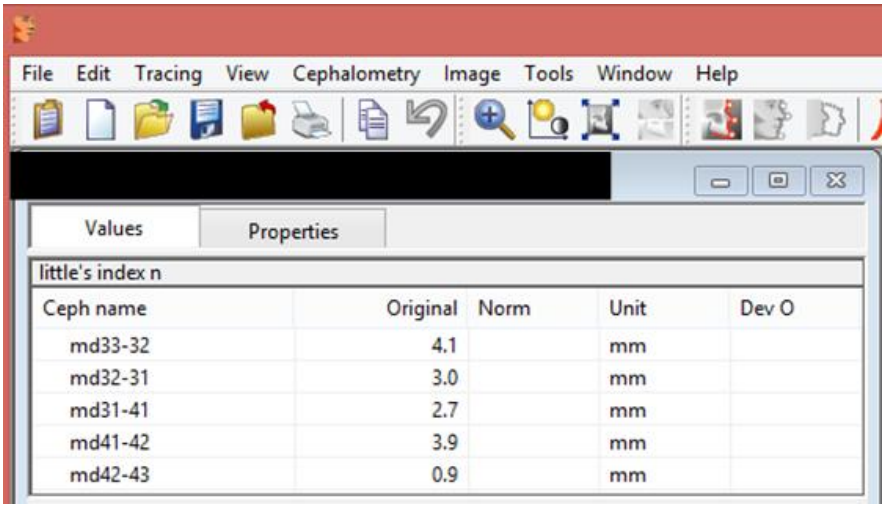
Post Hoc Tests

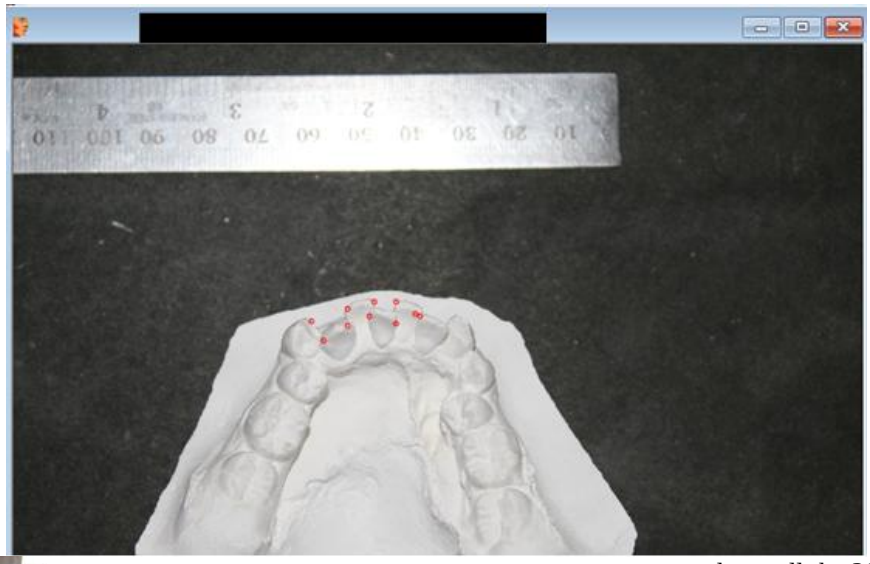
Multiple Comparisons

Dependent Variable: LITTLEINDEX

Bonferroni

(I) MODELS	(J) MODELS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Plaster models	CAD CAM	-.24000	1.34901	1.000	-3.6833	3.2033
	PHOTOGRAPHS	-.66000	1.34901	1.000	-4.1033	2.7833
CAD CAM	Plaster models	.24000	1.34901	1.000	-3.2033	3.6833
	PHOTOGRAPHS	-.42000	1.34901	1.000	-3.8633	3.0233
PHOTOG RAPHS	Plaster models	.66000	1.34901	1.000	-2.7833	4.1033
	CAD CAM	.42000	1.34901	1.000	-3.0233	3.8633





4. Discussion

In the present study the accuracy and reliability of two newer methods of study model analysis using FACAD and Blue-Cam (CEREC AC) generated digital models were compared to conventional plaster models measured using digital Vernier calliper.

To determine the accuracy of the newer methods, dental measurements were obtained, and little's irregularity index was calculated using all the three methods. To assess the intraexaminer reliability, were reassessed and the dental measurements were made on all the 30 records, twice by the same examiner at 1 week interval.

The present study showed that the dental measurements made using the study models obtained from the two newer techniques, did not reveal any statistically significant differences when compared with the 'gold standard' plaster models measured using digital Vernier calliper. Further, there were no statistically significant differences between the measurements made in both the digital formats. This is in accordance with several studies comparing plaster model with other digital imaging

The intraexaminer reliability was also good to excellent when the measurements were repeated on the three different methods of study model acquisition, by the same operator at 1 week interval.

In addition to the usefulness of plaster models, the Blue-cam generated digital model and digital photographs can also be used as an alternative to other methods of digital model acquisition and archiving, and for performing accurate measurement for study model analysis for orthodontic purposes - diagnosis and treatment planning.[32]

5. Conclusion

The dental measurements made on the two newer methods of study model analysis (FACAD and Blue-cam Generated digital models), compared to the conventional method of direct measurement on plaster model using digital Vernier calliper, did not show statistically significant differences in the little's irregularity index measurement.

Hence digital measurement using photographs in FACAD and Blue CAM generated digital models can be used as an alternative to the conventional measurement of plaster models using vernier callipers.

References

[1] Moorrees CFA, Marie Gron A, Boston massachusetts. Principle of orthodontic diagnosis. Angle Orthod. 1996 Jul; 36(3):258–62.

[2] Graber T. orthodontic diagnosis and treatment planning. Rocky Mt Orthod. 1982;742. Broadbent BH. A new x-

ray technique and its application to orthodontia. Angle Orthod 1931;1:45-66.
[3] Broadbent BH. A new x-ray technique and its application to orthodontia. Angle Orthod 1931;1:45-66.
[4] Hofrath H. Bedeutung der Röntgenfern und Abstands Aufnahme für die Diagnostik der Kieferanomalien. Fortschr Orthod 1931;1: 231-258.
[5] Vanessa P, José Luis G, Rosa C. Digital diagnosis records in orthodontics. An overview. Clinical Dentistry. 2006;11:E88-93.
[6] Han UK, Vig KW, Weintraub JA, Vig PS, Kowalski CJ. Consistency of orthodontic treatment decisions relative to diagnostic records. Am J Orthod Dentofacial Orthop. 1991 Sep; 100(3): 212–219
[7] Lee SJ, Gallucci GO. Digital vs. conventional implant impressions: efficiency outcomes. Clin. Oral Impl. Res. 24, 2013, 111–115.
[8] Keating AP, Knox J, Bibb R, Zhurov AI. A comparison of plaster, digital and reconstructed study model accuracy. J Orthod. 2008 Sep; 35(3): 191-201
[9] Redmond WR, Redmond WJ, Redmond MJ. Clinic implications of digital orthodontics. Am J Orthod Dentofacial Orthop. 2000 Feb; 117(2): 240-1
[10] Redmond WR. Digital models: a new diagnostic tool. J Clin Orthod. 2001 Jun; 35(6): 386-7.
[11] Peluso MJ, Josell SD, Levine SW, Lorei BJ. Digital casts: an introduction. Semin Orthod. 2004 Sep; 10: 226-38.
[12] Marcotte MR. The use of the occlusogram in planning orthodontic treatment. Am J Orthod. 1976 Jun; 69(6):655-67.
[13] Champagne M. Reliability of measurements from photocopies of study models. J Clin Orthod. 1992 Oct; 26(10): 648-50.
[14] Nollet PJ, Katsaros C, van 't Hof MA, Bongaarts CA, Semb G, Shaw WC, Kuijpers-Jagtman AM. Photographs of study casts: an alternative medium for rating dental arch relationships in unilateral cleft lip and palate. Cleft Palate Craniofac J. 2004 Nov; 41(6): 646-50
[15] P J Keating, R A Parker, D Keane and L Wright. The holographic storage of study models. J Orthod. 1984 Jul; 11(3): 119-125
[16] Buschang PH, Ceen RF, Schroeder JN. Holographic storage of dental casts. J Clin Orthod. 1990 May; 24(5): 308-11
[17] Berkowitz S. Stereophotogrammetric analysis of casts of normal and abnormal palates. Am J Orthod. 1971 Jul; 60(1): 1-18.
[18] Luthardt RG, K€uhmstedt P, Walter MH. A new method for the computer-aided evaluation of three-dimensional changes in gypsum materials. Dent Mater. 2003 Jan; 19(1): 19-24.
[19] Luthardt RG, Walter MH, Quaas S, Koch R, Rudolph H. Comparison of the three-dimensional correctness of impression techniques: a randomized controlled trial. Quintessence Int. 2010 Nov-Dec; 41(10) 845-53.
[20] Dalstra M, Melsen B. From alginate impressions to digital virtual models: accuracy and reproducibility. J Orthod. 2009 Mar; 36(1): 36-41.
[21] Persson AS, Oden A, Andersson M, Sandborgh-Englund G. Digitization of simulated clinical dental impressions: virtual three-dimensional analysis of exactness. Dent Mater 2009 Jul; 25(7): 929-36.
[22] Chandran DT, Jagger DC, Jagger RG, Barbour ME. Two- and three-dimensional accuracy of dental impression materials: effects of storage time and moisture contamination. Biomed Mater Eng. 2010; 20(5): 243-9
[23] Sjogren AP, Lindgren JE, Huggare JA. Orthodontic study cast analysis—reproducibility of recordings and agreement between conventional and 3D virtual measurements. J Digit Imaging. 2010 Aug; 23(4): 482-92.
[24] Boldt F, Weinzierl C, Hertrich K, Hirschfelder U. Comparison of the spatial landmark scatter of various 3D digitalization methods. J Orofac Orthop. 2009 May; 70(3): 247-63.
[25] Kurbad A. Impression-free production techniques. Int J Comput Dent. 2011; 14(1): 59-66.
[26] Kachalia PR, Geissberger MJ. Dentistry a la carte: in-office CAD/CAM technology. J Calif Dent Assoc. 2010 May; 38(5): 323-30.
[27] Quimby ML, Vig KW, Rashid RG, Firestone AR. The accuracy and reliability of measurements made on computer- based digital models. Angle Orthod. 2004 Jun; 74(3): 298–303
[28] Moshiri M, Scarfe WC, Hilgers ML, Scheetz JP, Silveira AM, Farman AG. Accuracy of linear measurements from imaging plate and lateral cephalometric images derived from cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 2007 Oct; 132(4): 550–560.
[29] Hilgers ML, Scarfe WC, Scheetz JP, Farman AG. Accuracy of linear temporomandibular joint measurements with cone beam computed tomography and digital cephalometric radiography. Am J Orthod Dentofacial Orthop. 2005 Dec; 128(6): 803–811
[30] Kapila S, Conley RS, Harrell WE Jr. The current status of cone beam computed tomography imaging in orthodontics. Dentomaxillofac Radiol. 2011 Jan; 40(1): 24–34.
[31] de Waard O, Rangel FA, Fudalej PS, Bronkhorst EM, Kuijpers-Jagtman AM, Breuning KH. Reproducibility and accuracy of linear measurements on dental models derived from cone-beam computed tomography compared with digital dental casts. Am J Orthod Dentofacial Orthop. 2014 Sep; 146(3): 328 – 336
[32] Bell A, Ayoub A.F, Siebert P. Assessment of the accuracy of a three-dimensional imaging system for archiving dental study models. J Orthod. 2003 Sep; 30(3): 219-223.