Reliability of bolton teeth ratio in dual pour alginate impression with plaster and digital models

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Abstract

Aim: The purpose of this study was to compare the values of Bolton ratio for plaster dental casts versus software -based dental models made from a dual pour alginate impression.

Materials and Methods: Maxillary and mandibular alginate impressions were made for a sample of thirty-six patients with permanent dentitions from first molar to first molar. Impressions were poured in plaster allowed to set for 8-10 minutes. Casts were removed after cleaning second plaster poured. Thus without damaging dual pour procedure were performed. For digital casts, obtained plaster casts were Scanned and imported into software to perform digital cast's analysis.

Measurements of mesiodistal tooth width were made using digital calipers or Nemoceph software. Overall and anterior Bolton analyses were performed for all models. Measurements were repeated no less than two weeks later. Results were statistically analyzed for correlation coefficients and student t –test was performed.

Results: Correlations showed very high intrarater reliability for measurements made on both plaster and digital casts. Boltons ratio has shown statistically significance differences between plaster and digital casts in mesiodistal measurements of both maxillary and mandibular arches.

Values of mean difference between plaster and digital casts were 0.68 mm in the maxillary arch and 1.35 mm in the mandibular arch. Value of mean difference between plaster and plaster and between digital and second pour were negligible.

Conclusions: This study concludes that first pour plaster casts and second pour plaster casts has negligible differences, similarly between digital casts thus it is significant that both casts can be used for multiple uses depending up on clinician experience.

Introduction

Orthodontic treatment outcome has remained a challenging task for orthodontist to acquire safe, efficient, stable and predictable as per patient's desire. Comprehensive treatment outcome depends upon accurate dimensional relationship between the maxillary and mandibular teeth to assure proper interdigitation, overbite and overjet establishment[1-2].

Establishing accurate inter digitation, overjet, and overbite implicate amount and location of a tooth size discrepancy in pre- treatment, as interarch tooth size discrepancies necessitate either removal or addition of tooth structure to open or close spaces in the opposing arches.[2-3]

Several studies have been reported that inter digitation of dental arches are under the influences of tooth size variation (C.W. Neff et al 1949), established anterior proportionality index and tooth size discrepancy index were failed to accept. Wayne A Bolton succeeded to explain and developed formula to anterior ratio (77.2), and overall ratio (91.3) on study models.[1-3]

W.A. Bolton in 1958 developed Bolton index, most significantly used, considered as seventh key of occlusion, and describes interarch discrepancies in tooth sizes. A sum of 55 persons study models with perfect occlusion was taken for the study to generate overall and anterior ratio. Application of Bolton analysis was that it provides information during orthodontic treatment, helps in evaluations pertaining to clinically relevant treatment planning decisions.[3-4]

The study models were fabricated with traditional dental plasters in orthodontic practice. However, the introduction of computer-based study models with analyzing computer software in all three dimensions has given birth to digital study models. Several studies have been reported in comparison with conventional plaster the digital study models were found to dimensionally stable for representations and for analysis.[1-5]

Few studies done(Tomassetti, et al., 2001 ,Garino, F. and Garino, JB, 2002 ,Whetten et al., 2006; Zilberman et al., 2003, Santoro et al., 2003, Quimby et al., 2004, Costalos et al., 2005 Rheude et al., 2005, Mayers et al., 2005, Stevens et al., 2006; Mullen et al., 2007, Okunami et al., 2007, Leifert et al., 2009). With aim to determine statistical, dimensional and analytical difference in conventional and digital study models. However, most of these studies were concluded reporting insignificant difference was seen between conventional and digital study models.[3-6]

Very rare studies have been done with multiple pours of alginate impression in respect to its impact on dimensional accuracy of digital study models and its implication on statistical and clinical applications.

Aim of this paper is to compare value obtained by Bolton analysis from conventional study models against computer-based renderings (digital models) from dual

pour of alginate impression and to determine its statistical difference.

Material and Method

The sample, in this study there were sum of 36 undergraduate students studying in Mansarovar Dental College, Kolar Road, Bhopal were included (13 male and 23 female) between the age group of 18-28 years. Sample selection was done after screening of 643 students.

The following are the selection inclusive criteria

- Full erupted all permanent teeth excluding the third molars on both side of arch.
- No history of orthodontic treatment/ orthodontic extraction/ stripping.
- Teeth showing normal developmental morphology were included.
- Class I molar and canine occlusion

The following are exclusive criteria

- Grossly caries
- Missing molars / present on one side.
- Congenital abnormalities
- Teeth wearing, attritions,
- Heavy restorations, onlay, crowns.

Fig. 1: Instruments' required

The method

Each student individually screened as per inclusive criteria and 36 students were included in our study. Two sets of trays were used to take two sets of impressions to each student to produce 36 sets of stone models and 36 sets of digital models. To assess considerable alterations among plaster and digital casts maxillary and mandibular alginate impressions.

Impressions were spewed disinfectant, and stored under rubber bowl within an hour poured in orthodontic stone. To pour second time casts were allowed to set for 8 -10 minutes, and cast removed from the impressions without avoid any damaging cast and alginate impression. To second pour impression was cleaned gently poured with stone. Thus, two caste were fabricated trimmed polished each for study models manual and for digital. Cast was scanned with digital scanner and points were registered 1st molar right to 1st molar of left side.

Measurements

Measurements of mesiodistal tooth width were made using digital calipers and software for NemoCeph. Overall and anterior Bolton analyses were performed for all models. Measurements were repeated after 15 days to minimize errors for all models in the same.

Fig. 2: Measuring teeth dimension with digital caliper

Mesio-distal widths measurements

Study models the measurements were evaluated with vernier caliper inserting parallel to long axis of tooth. However, the digital method, measurements were done with a standard computer mouse to draw the distances from point to point on the scanned computer models.

Arch length measurements

Segmental approach was performed to measure study model and digital model.

a. Segment A: is the distance from mesial contact point of the right first molar to the mesial contact point of the right canine.
b. Segment B: is the distance from the mesial contact point of the right canine to the mesial contact point of the right central incisor.
c. Segment C: is the distance from the mesial contact point of the left central incisor to the mesial contact point of the left canine.
d. Segment D: is the distance from the mesial contact point of the left canine to the mesial contact point of the left first permanent molar.

On the digital model,

- Three segments were divided, three measurements appeared;
- The posterior arch width, the anterior arch width, the canine width

Calculations

Mesiodistal widths of teeth were measured and summation of both maxillary and mandibular was done on plaster and digital models separately. (Table 1)

Statistical analyses

Two examiners trained to measure plaster cast both immediate and double poured with vernier caliper, while digital cast were measured with a standard computer mouse was used to draw the distances from point to point on the digital models and to minimize error 15 days later similar measurements were repeated on same cast, and mean values were taken for study.

Obtained values were analyzed with appropriate statistical analyzer SAS version 17, and descriptive statistics such as mean, standard deviation (S.D.), standard error (S.E.). Furthermore, inferential statistics such as paired sample and coefficient correlation were calculated. Paired sample includes t-test to evaluate difference between immediate pour plaster model (manual and digital) and second pour manual, digital; also Coefficient of correlation was calculated between them.

Results

Descriptive statistical analysis reveals that the measured mean values were significantly more in plaster cast (immediate pour and second pour) and digital model (immediate pour and second pour).

Statistical analysis for reliability reveals significant correlation between first pour and second measurements, demonstrating excellent reliability (Table 1). The mean and standard deviation between the first pour cast and second cast measurements shows each segment with very small absolute values. However, there was very significant and immense difference seen between plaster cast and digital model measurements (Table 2).

Paired samples t- test revealed non-significant differences between the two measurement methods. Coefficient of correlation demonstrated highly significant, strong correlation between the two methods (r= 0.92, p-value < 0.01). The immense difference seen between plaster model and digital (Table 2).

Table 1: Coefficient Correlations between First and Second Measurements

Sl. No	Measured correlation		Segments	Type models
	Anterior	Arch		
1	0.979	0.946	Maxillary	Plaster
	0.954	0.966		
2	0.954	0.978	Mandibular	Plaster
	0.964	1.2		
3	0.986	1.23	Maxillary	Digital
	0.990	1.43		
4	0.989	1.75	Mandibular	Digital
	0.988	2.10		

Table 2: Mean Difference, Standard Deviation, and T-test Significance Measurements

	Measured mean		Measured Standard Deviation		T-test Significance	Segments
	Anterior	Arch	Anterior	Arch		
Plaster models	0.25	-0.34	0.54	1.55	P= 0.005	Maxilla
	0.27	0.33	0.57	0.89	P= 0.005	Mandible
Digital models	-0.11	-0.31	0.44	0.64	P= 009	Maxilla
	-0.18	-0.81	0.27	0.52	P= 0.009	Mandible

Discussion

Availability of impression materials from different manufacturer are susceptible to posses least resistance in dimensional stability. Considering cost benefit practitioner must choose appropriate material possessing clinically accurate and high resistance to alteration in dimensional stability of both positive and negative replica of impression material. Hence, the appliances fabricated on it, must be most accurate to fit in oral cavity.[1-7]

The possible implication of casts in orthodontics are for diagnosis, treatment planning, evaluating treatment outcomes, fabrication of appliances (retainters, expanders functional appliances), and represent hard and soft tissue relationships. However, digitized cast models from single/double pour alginate impressions possess accuracy and validity in most aspects of diagnosis and treatment planning in clinical orthodontics.[4-8]

Our study was aimed to clarify the impact of pouring alginate materials twice with respect to its effect on tooth size measurements. Obtained results of our study illustrate that there is significant difference established in mesiodistal dimensions in the anterior segment with respect to complete arch during a first-pour plaster cast to second-pour along with digital analog.[6-9]

In digital casts Bolton analysis /ratios clarify that significant difference between first pour and second pour cast, may be due to standard alginate properties like imbibitions, syneresis, scanning magnification, or distortion due to removal of first pour cast. However, impact of varying property must be taken in to consideration during treatment planning (Quimby et al. 2004).[10-12]

As our study concludes that dual pour plaster cast shows negligible statistical differences in comparison with dual pour digital measurements. The absolute differences in the measurements for plaster taken against those of digital casts had such a small range (0.33-0.70 mm in the anterior arch and 0.68-1.35 mm over the entire arch).[11-13]

Implication of our study in clinics that reduces both doctor and patients chair side time, prevents wastage alginates materials, because dual pour plaster cast can be utilized for orthodontic diagnosis, treatment planning and outcome assessment , also can be used to fabricated some intermediate orthodontic appliances.[9-13]

Furthermore, differences seen in calculated Bolton rations may be due to uneven distortion to impression material during dual pour and also the long period of time between pours had little effect on the impression anatomy, as was suggested by Quimby et al. (2004).[1-14]

However, current investigation done on traditional alginate impression with extended pour alginate. The study concluded that traditional alginate persevering under standard conditions have shown better dimensional stability and no difference in Bolton ration, thus it shows that dual pour plaster casts are as accurate as single pour, can be used for clinical diagnostic and appliance fabrication (Imbrye et al 2010).[1-14]

One constraint of this investigation occurs due to the fact that no observations were made whether differences in measurements exist between two sets of plaster casts, or between two sets of digital casts, that were both fabricated from dual-pour alginate impressions. If differences between first and second pours of casts in a single medium have similar differences to those seen in this study, one may conclude with greater certainty that the secondary pour of the impression led to the differences observed.[12-15]

However, if differences between first and second pours do not exist in similar medium, or have a more uniform difference in measurements that does not affect Bolton ratios, then the observed differences in this study likely result from making the measurements in different media.[15]

Furthermore, the differences observed impact diagnostic criteria limited to measurements of mesiodistal tooth dimensions. Further investigations that focus on other aspects of the cast anatomy and the relative positions of their constituent parts are necessary to help reveal the full clinical impact of dual pour alginates, particularly for treatment planning and treatment outcome assessment. This would aid clinicians in establishing an evidence-based comfort level with pouring alginate impressions twice.[6-15]

Conclusion

The accurate data recording plays vital role in evaluating both treatment plan and treatment outcome with the help of dental casts. From the beginning, alginate impressions were used with single pour and single cast for various uses such as, in orthodontics, including diagnosis, treatment planning, diagnostic wax-ups and fabrication of appliances.

The main aim of our study was to evaluate Bolton ration for first pour and second pour plaster casts and compare with digital measurements from a dual pour alginate impression in order to determine the validity and reliability of computer-based models and second pour casts.

Two sets of measurements of mesiodistal tooth width were made on the plaster casts using digital calipers and on the computer-based models using proprietary software. Overall and anterior Bolton analyses were performed.

With help of appropriate statistical analysis (t-test), dual pour plaster casts have shown that very minimal differences seen in both first and second pour. However, significant difference seen in the computer based digital calibrations. Hence this evidence will allow clinicians to decide whether a dual pour technique is appropriate for their clinical practice of orthodontics.

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