Surface area measurements of upper dental cast with different final impressions

Reem Abdul Rahim, B.D.S., M.Sc. [(1)]

ABSTRACT

Background : surface area anatomy is a proportional point to the retention of complete denture, in past there was no quantitative method to evaluate the surface area, nowadays the size and shape of maxillary arch is measured by different electronically and mathematical devices. A study was therefore, undertaken to measure surface area of upper dental cast that was taken by different final impressions.

Materials and methods: twenty patients were examined. All of them had a healthy palate with no singe of injury, trauma, or deformity. Casts were taken by three different final impressions; zinc oxide, additional silicon, and poly ether. And two different devices were used; the computerized one and the Aluminum foil measure. Age, sex, and shape of upper dental arch were also evaluated.

Results: the results of this study showed that the use of different methods to measure the surface area of upper dental cast had a significant difference between the two different measurements, while there was no difference in the measurements between the different final materials. Age variable showed more significant difference between the first and second method than sex variable.

Conclusion: data collected in the present investigation showed a highly significant difference in measurements between the computerized method and the direct foil method. Zinc oxide, silicon and poly ether materials showed no significant differences in readings.

Keywords: Surface area, final impression, digitalized measure of dental cast. (J Bagh Coll Dentistry 2013; 25(2):36-40).

INTRODUCTION

Assessment of surface area is an important factor in dental prosthesis; it has been proved that the retention of complete denture is proportional to its anatomic surface area [(1-3)]. The size of the arches is being important from the standpoints of denture retention; larger area of hard palate is greater for developing good retention of upper denture [(4)]. Also the form of the dental supporting tissues become more important in denture retention , with tapering arch is considerably less than with other forms; square , and ovoid forms [(1,5)]. With all these facts dental cast analysis is a three- dimensional assessment of the maxillary and mandibular dental arches, and this is one of the basic tools of diagnosis and treatment planning in prosthesis [(6, 7)].

So many measurements techniques have been used to obtain data of palatal tissue bearing area; some researchers used the direct standardized land marks that used as end points of the measurements on the cast, but this method was unfortunately time- consuming, and no derived future data could be obtained [(8,9)]. Others used the indirect analyzing data of two-dimensional photographic and radiographic projections, but this data losing the third dimension, with some errors in the picture dimension by optical camera [(8, 10)]. With the development of the scientific researches, using computerized measures provide an accurate description of normal palatal size and shape [(11-13)].

(1)Lecturer. Department of Prosthodontics, College of Dentistry, Baghdad University.

Till now, there were so little methods measuring surface area of dental arch specifically, so in this study, the surface area of maxillary dental cast had been calculated directly by mathematical equation and compared with the computerized digital method using three- different final impressions to compare surface area data between these different dental casts related to each materials, age, sex of the patients and morphology of the palate were also evaluated.

MATERIALS AND METHODS

Sample

Sixty upper dental casts for twenty patients were made, (12 males, and 8 females). Each subject should have a healthy palatal tissue; with no evidence of trauma, injury, or deformity to be included in this research. Every patient had received a three different types of final impression materials for his upper casts; zinc oxide eugenol (SS White), additional silicon (hydrophilic vinylpolysiloxane addition silicon impression material) (Zhermack, elite p&p), and polyether (3M Espe, Impregum TM.Soft). Each material was mixed and submitted to the trays according to their mixing, working, and manipulating time of manufactures specific for each material. These three- different final impression materials were selected because of their properties of dimensional stability and accurate restoration of details [(14-16)]. After setting of these impression materials inside the patient mouth, maxillary cast were made with dental stone type IV(Zhermack, elite rock), this type of stone has a characteristics of surface accurate details [(15, 17)].

Digitalization of maxillary casts and mathematically equation:

The method was derived from the original description made by Ferrario et al [18]and Hamdi et al [2] , on each cast, the intersections of lines were drawn as fellow land marks; straight line between the most anterior base of labial frenum and most posterior palatal foveae and this represent the length of cast (L) along the median palatine line; width (W) is represent the average of straight lines(about six readings) distributed in anteroposterior direction along the denture supporting area; and(H) is the average height of the crest of the ridge relative to the corresponding point on the median palatine line (average of six readings evenly distributed in an anteroposterior direction) Fig (1).

With the current technology that provide a computerized digitizers that can directly used on dental casts to supply metriccordinates of selected land marks. In this study we use the ordinary scanner to take a picture with its original dimensions of the casts without any change in the optimization or resolution readings of any indirect optical photo device, these pictures were directly evaluated and measured through data analyzed in the computer [9,18]. Approximation formula was developed that expressed the maxillary denture- supporting area (A_D) as a function of three distances between anatomic landmarks [2, 3]:

$A_{D=}\ {}_{\pi}L\ W/6 + 5L\ [\ (\pi h / 4)^2 + (W/6)^2\ ]^{½}$ This mathematical equation was computerized and data were obtained.

Use of Aluminum foil to measure surface area:

For each patient a final impression of zinc oxide eugenol, additional silicon, and poly ether materials for maxillary arch were poured with dental stone type IV to obtain a master model.

According to Salman's theory[4]; an outline representing the extension of the upper denture base was marked on the model) , the line was passed through buccal and labial sulcus and extended onto the palatal area representing the posterior extension of the denture base. An Aluminum foil of (29.12) µm thickness was adapted to the model within the determined outline without any bending of the foil, this was obtained by cutting the foil to six pieces to avoid folds Fig (2) , For measurement of the surface area of the denture bearing mucosa the following equation was followed [19]:

$$\text{Surface area of denture Bearing mucosa (cm)}^2 = \frac{\text{Weight of Al. foil pieces (mg)}}{\text{Weight of 1 cm}^2\text{ Al. foil piece (mg)}}$$

The weight of Aluminum foil piece could be obtained by weighting the cut pieces of Aluminum foil using Amput analytic balance , Fig (3), while the weight of 1cm^2 Aluminum foil piece was equal to (3.33) mg/ cm^2. Measurements of the foil were calculated at the Ministry of Science and Technology at the department of measurements.

Statistical analyses

Statistical measurements were analyzed to assess the results of the present study; descriptive statistics: mean (M) and standard deviation (SD) were assessed for both variables age and sex for both digitalized computer method and the Aluminum foil method. The analysis of variance (ANOVA) and multiple comparisons, with p= 0.05 as a significant level of difference were performed.

RESULTS

Table (1) and (2) were shown the descriptive mean and standard deviation of the digitalized method and the Aluminum foil method for both variables; age and sex. Table (3) and (4) showed that there was no significant differences between the three different final impressions; zinc oxide eugenol, additional silicon, and poly ether materials in surface area measurements for both methods of measuring (digitalized and Aluminum foil method ($p \geq 0.05$).

Table (5) with (ANOVA) test analysis showed that there was a highly significant difference in readings between the first method (Al. foil) and second method (digitalized computer) with p-value of (≤ 0.01).

Table (6) showed the descriptive analysis of surface area for both two different distinguished area forms in this study; oval and tapered arch form, this table showed that most females with tapering arch form and smaller surface area measurements than males with oval arch form and larger size of surface area measurements.

DISCUSSION

The proportional area of the ridge and the palate to the total denture foundation area may be of considerable significance in the retention and stability of maxillary complete denture and to measure this basal seat area is of considerable importance to evaluate possible meanings of increasing such variable prosthetic properties [2,7,8].

Measurements of upper surface area of dental cast were evaluated in this study by using two different measuring methods. The first method is to measure the area of upper basal seat by using

mathematic equation and measuring the corresponding data directly on the upper stone cast. The second method was to measure the maxillary surface area by using the digitalized scanner device and three different final impressions were used in this study; zinc oxide euogenol, additional silicon and poly ether materials to compare the difference in measurements of surface area between these three different materials.

Data obtained from this study showed that both the direct Aluminum foil method and the digitalized method were of similar results; that surface area measurements for zinc oxide euogenol, additional silicon, and poly ether materials were of non-significant differences between them and this results revealed the fact that these materials showed almost a similar accurate details in stone cast registrations [16,20-22].

The use of two different methods to measure the upper basal seat area of the denture corresponding to the maxillary cast showed a highly significant difference between the Aluminum foil method and the newly digitalized method, this result came in agreement with the fact of the need for newly computerized device is nowadays widely used because of their best detailed image, less time consuming and more accurate measurements with less error accumulation than the direct distance measurements [7,23,24], also difference in the measuring between these two different method; that Aluminum foil method give an three distance measurements of length, width and height directly from the cast but with error identification of percentage more in landmark identification than for the landmark digitalization for the same cast [8, 18, 28].

Age, sex, and palatal morphology were also evaluated in this study, that these three factors of great importance for definitive diagnosis and optimal prosthetic goals [26,27]. The changes of oral structures (both dental and skeletal) still continue to modify; and as expected the changes occurring as slower rate than the observed during the first two decade of life [15,27].

In this investigation, the results showed that the age variable show a significant difference for both types of measuring methods for the different three final impressions ($p \leq 0.05$), this results come in agreement with the findings of Harris and Bondvik [15] who reported that hard palatal tissue dimensions showed increased in dental arch with aging, but disagreed with the results found by Bishara et al who found that decrease in dental arch measurements with aging, and this may be due to the different techniques and materials used in this study [15,28].

Surface area measurements in women were of non-significant difference than mean, this came in agreements with the findings of Ferrario et al who found that both males and females had the same experience of dental arch measurements [8,27]. Carrillo et al found that males had longer diameters of dental arch than females, this difference in findings may related to the different ethnic groups shared in these different investigations [26]

Arch form was also discussed in this study that oval shape arch shape showed larger surface area dimensions than that of tapered arch forms, this results agreed with all investigations that under taken to discuss the palatal arch form [6,11,18,26].

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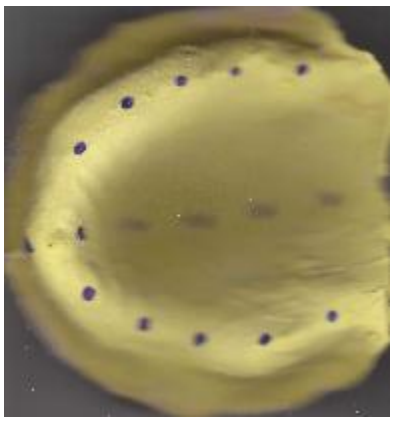

Figure 1: Average of six readings evenly distributed in an anteroposterior direction

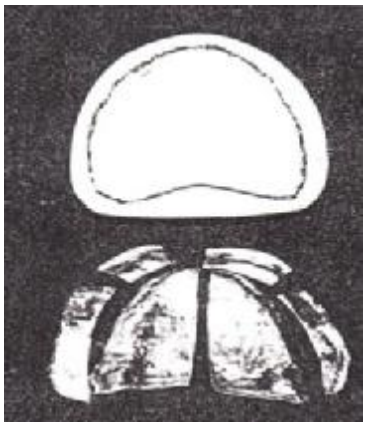

Figure 2: Cutting the foil to six pieces to avoid folds.

Figure 3: Amput analytic balance

Table 1: Descriptive of first and second methods

		Z	S	P
First Method	**Mean**	42.692	40.090	35.786
	SD	6.8991	5.7040	7.6488
Second method	**Mean**	42.058	39.330	46.412
	SD	9.8384	8.6289	9.2620
Age	**Mean**	64.2		
	SD	8.343		

Table 2: Descriptive of first and second methods by sex

Genders	Method		Z	S	P
Males	First Method	Mean	45.211	41.791	38.121
		SD	6.063	4.868	8.058
	Second Method	Mean	48.01	44.23	40.97
		SD	7.061	7.139	8.926
	Age	Mean	66.7		
		SD	8.026		
Females	First Method	Mean	38.91	37.53	32.284
		SD	6.649	6.2168	5.7782
	Second Method	Mean	33.12	31.969	29.576
		SD	5.679	4.333	4.3128
	Age	Mean	60.4		
		SD	7.781		

Table 3: LSD of the two methods between the different final impressions

	First method		Second method	
	P	Sig	P	Sig
Z&S	0.009	S	0.007	S
Z&P	P≤0.01	HS	P≤0.01	HS
S&P	0.008	S	0.026	S

Table 4: t-test between first for the different final impressions

	t-test	P-value	Sig
Z	0.313	0.758	NS
S	0.380	0.709	NS
P	0.309	0.761	NS

Table 5: ANOVA test between the first and second methods

	F-test	P-value	Sig
First method	13.829	P≤0.01	HS
Second method	12.955	P≤0.01	HS

Table 6: mean values between male and female according to the arch form

			Arch form male	Arch form female
First method	Mean	Z	45.211	38.91
		S	41.791	37.53
		P	38.121	32.284
Second method		Z	48.01	33.12
		S	44.23	31.969
		P	40.97	29.576