Nat. Volatiles & Essent. Oils, 2022; 9(1): 1122-1145

Evaluation Of Splint Effect On The Dimensional Variations Of Implants Location Transfer With A 25° angle By Open Tray Molding Method

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Abstract

One of the major purposes of making a prosthesis based on implant is to produce a superstructure by a Passive Fitness. If such a Passive Fitness is not met, then the implant components will fail which will ultimately result in the failure of the treatment. The aim of this research is to assess the effect of Splint on the dimensional variations of implant location transfer with a 25° angle by Open Tray Molding Method using polyether material. The research by an experimental-laboratory method was rendered on 15 specimens by 3 implant systems, tantamount to 45 specimens in each group, and with 6 points (A,B,C,D,E,F). In order to produce the master cast of Velmix gypsum type IV and a vacuumed blender were used. By either of the Splint and Non-Splint techniques, 15 times molding was separately performed. Upon hardening of the gypsum, for a concurrent measurement of the casts, they were placed on the mantining plate by use of a clamp, and by a multi axes Coordinator (x-y-z), it was used on the upper surface of the hex implant and the base of the cast. The statistical analysis used in this research was T-Test. The results of the research showed that the range of the dimensional variations of the implant location transfer by Non-Splint technique estimated at 170.2±68.4, and by Splint technique it was estimated at 169.8±71.7, and the T-Test demonstrated that statistically such difference was not significant. Thus, given that the Non-Splint molding method did not show a significant effect in diminishing the dimensional variations by Splint method, and due to ease of manipulation and reduced time of molding process, the Open Tray Non-Splint method is recommended.

Key Words: Implant, Molding, Splint and Dimensional Variations

1.Introduction

In order to transfer the location of implants from the mouth to the work cast, two major techniques of molding called, Non-Splint Open Tray and Splinted Open Tray were used. In the former technique, Impression Transfer Coping is picked up in the mouth by the molding upon exit from the mouth. In this technique, in order to have access to the lower screws for molding, upper holes are required which have to be precisely placed on the molding copings, so that cleansing can be implemented appropriately and easily. By Open Tray, the method is such that the molding copings are fastened onto the implants, and the tray is filled with the molding material, and it is implanted in the mouth. Upon hardening of the material, the copings impression screw is unfastened through the wetting holes, and it is taken out of the mouth (Mish CE, 1999). The latter method is also performed by Open Tray molding, but the difference is that the implants placed on the model are splinted to one another by Dural Acryl in the laboratory, and the specific tray is made, and then the molding is performed by the Open Tray method (Guedes & Carbal, 2007). This research which intends to decide the effect of the Splint on the dimensional variations of the implants location transfer by 25° Open Trany method, with a molding material of polyether through In vitro method was implemented in the fixed prosthesis ward of the dentistry school in Tehran Islamic Azad University in 2010-2011.

2. research literature

Dimensional variations as a result of shrinkage in the molding material, are due to the polymerization reaction and the produced auxiliary and vaporizing materials, or by the pressure applied during the molding, or the molding technique. In order to obtain the Passive Fitness, it will be imperative to prepare a precise molding of the implant. The word "Passive Fitness" in the Implant Science refers to a state of the prosthesis fitness in which the implant trunk bears adequate fitness for the adaptation and concurrent remodeling (Seyedan et al., 2008). Passive Fitness was announced about 10 micron by Branemark (Rismanchi & Moniri Fardi, 2009).

Production of a superstructure with a passive fitness is one of the major purposes of making a prosthesis based on implant. It is necessary to prepare a precise mold without dimensional variations therein prior to its casting to provide such passive fitness (Rismanchi & Moniri Fard, 2009). Should such passive fitness be not gained, the implant will be exposed to pressure which may be contributed to the crash of the implant components and failure of treatment. The forces which are applied to implant due to impassive superstructure, may result in deterioration of the bone around the implant, ischemia in implant and recovery by non-mineral tissue around the implant, mechanical failure, loosening of implant components, and failure of restoration (Holst et al., 2007).

There are many ways to meet a stress free fitness, but there is no single and definite protocol for it (Chio JH et al, 2007). Nowadays, it is believed that the molding materials are of so advanced nature that the adoption of a proper technique is the decisive factor (Holst et al., 2007), and also the precision in casting is not affected by the viscosity of the molding material, but it is affected by the molding methodology (Walker Borello Walker, Ries, 2008). In another research launched in 2011, it is so pointed out that by the implant capabilities, these days more highlight is placed on precision and succinctness of the prosthesis (Prithviraj et al., 2011). Progress in the molding techniques to reach the highest precision of recording the implant position attracted the most attention (Prithviraj et al., 2011). However, in another research, the molding tray (steel precast, plastic precast or specific tray) was examined for the rigidity of the molding tray type and the manner in which the molding materials are distributed, and the tray type was mentioned as the major factor to determine the Passive Fit (Sazgara & Nahidi, 2008).

For the first time Brane Mark noticed the significance of Splinting and connection of molding copings to one another in the mouth to reach more precision in the molding (Branemark, 1983). The said technique was also adopted, by the other researchers with a little change therein. In order to achieve a more precise mold, Zarb used the connection of molding copings by a teeth thread and a self-polymerizing Acrylic resin (Branemark et al., 1990). In some other articles, no significant difference was reported between the precision of the said method and the Non-Splint molding methods (2, 10, 11 and 12, Del' Acqua et al., 2008, and Carr, 1991, Choi et al., 2007). Meanwhile, certain articles considered Splinting as an element in reducing the precision in molding the implants (Wee, 2000). Accordingly, given the mentioned controversies, the aim of this research is to examine the effect of Splint on the dimensional variations of the implants location transfer of 25 degree angle by the Open Tray molding method and using polyether, onto the produced model through In Vitro in the fixed prosthesis ward of dentistry campus of the Islamic Azad University in 2010-2011, the obtained results of which are considerably useful. Eventually, the main question raised in this research is that: How much is the effect of the Splint on the dimensional variations of the implants location transfer with a 25 degree angle, by the Open Tray molding method?

2.1. Research Background

In 2004, Vigolo and et al made a study to evaluate the precision of 3 molding methods by use of polyether material for the implant prosthesis (repeated internal connection). In that research, a model was made of Acrylic resin substance, and 4 implants were placed therein. 45 molds of polyether were taken from the foregoing model by using square coping methods through Open Tray technique. Three groups, each including 15 specimens, were resulted by use of various molding methods; in the first group, the square copings were used without any change; in the second group, prior to molding, the square copings were connected to one another by the self-polymerized acrylic resin; and in the third group, the square copings which had been already grinded by the air borne particles, were covered by the adhesive which had been proposed by the factory. After moldings, the analog of the implants were connected to the coping, and then the molds were cast by use of Stone Type 4 approved by the ADA. A calibration assessor who was unaware of the used molding method, measured the precision of all casts by use of the analogs of the implants, and using Profile Projector, with 10 X magnification. The obtained measurements were contrasted against the measurements made by reference resin model and used as the control group. The data were statistically analyzed by use of one way variance analysis test at level of <0.05 α, and the Student Newman-Keuls. The data resulted from Profile Projector under this study demonstrated that there had been major differences among these three implant molding methods (P<0.001). The Student Newman-Kelus test also revealed major statistical differences among the groups. Meanwhile, the molds produced in the second group, compared with the first and third groups, demonstrated more precision (P<0.05). In the end, it was so concluded that the molding precision is higher by the method of connecting the square copings to the self-polymerized acrylic resin (Splinting) to make the implants of internal connection (Vigolo et al., 2004). As to the advantages of this research, it has to be pointed out that: 1. The number of the studied specimens was adequate; 2. In this study, in order to avoid problems regarding the shrinkage due to acryl polymerization, and also to save the time, the copings were connected to one another prior to molding, and then they were disconnected from one another by a diamond disc, and they were connected to one another again immediately before molding by a brush and liquid powder; 3. The person in charge of measurement was well experienced and the assessment was performed in blind manner; 4. Benefiting from control group and comparing the data such group is deemed another advantage of the above study. Nevertheless, in this study, the spacing between the dual implants within the control group and the experimental groups was measured merely by the horizontal dimension, and the other dimensions were not taken into account, specially under the clinical conditions, by using various implants, placement of the implants to face one another, such spacing will become probably more, and its clinical application will encounter restrictions.

In 2007, L. M. Carbal and et al made a research titled “Comparative Analysis by 4 techniques of Molding for Implant”, which was performed by the laboratory method. Four molding techniques were assessed to decide the dimensional precision of the study, and the obtained results were compared with the standard technique. A main steel

Framework with two internal hex implants (Sao Paulo, Brazil SIN: Sistema De Implante Nacional Ltda) were adpted as the standard method for the comparisons, and 60 master casts were prepared to evaluate 4 molding techniques. Variance analysis and Tukey HSD test were used for statistical assessment of the data. The findings pertinent to the direct technique with the direct transfer copings splinted with acrylic resin were divided and they were once again connected to one another by resin. No significant difference was noticed as to the findings pertaining to the main steel framework (L. M. Carbal et. al, 2007). One of the advantages of this research was to use Splint method for the molding techniques. But the angles of the placement of the implants had not been pointed out therein.

In 2007, J. Heather and et al. made a research titled "Study on Precision of Two Molding Techniques by Angled Implant" and stated that the aim of this study is to specify the combinational effect of the implant direct and indirect molding and angled implant on one another, and the number of the implant on the precision of the final cast. The final Stone cast for 6 trial groups and one control group was carried out. All the 7 final cast groups had 3 implants placed as per the designed plan of the triangular pattern. In 6 trial groups, the central implant is perpendicular to the cast plan, while the exterior implants of 5, 10, and 15 degrees are nearer or farther from the central implant. In the final control cast, all 3 implants were parallel to one another and perpendicular to the cast plan. 5 moldings were made by Open Tray technique, and 5 moldings were made by Closed Tray technique, by the molding material of expanding silicone from the final cast. The molds were cast by the Type IV dentistry stone gypsum, and the measuring pen with a delicate head was used to record the details of different axes (length, width, and height), so that to adjust the upper plane of the hex implant onto the cast base. A computer software was used to balance the data, and a calculating vector to decide the difference in degree of implant angles in the final cast and duplicate cast. Anova statistical analysis was used to report measurement, and by Post-Hoc tests, a considerable interaction was noticed. The deviation angles in the Open Tray and Closed Tray molding techniques were not considerably different. The implant angle and the implant number were different from the average deviation angle, but it was not so much as to be easily interpreted. The interactive resulting from the molding technique, implant angle, and implant number had no effect on the precision of duplicate casts compared with the final casts. No considerable difference was noticed between the average deviation angles of the Open Tray and Closed Tray molding techniques. There was no interpretation pattern of the average deviation angle within the implant angle term and implant number. The magnitude of the deviation for all molding technique combinations, implant angle, and implant number was analogous (Heather J. et al., 2007). Different angles were used in this research.

In 2008, Seyedan and et al made a research titled “Dimensional Register of Polyether and Polyvinyl Cyloxan Materials for Different Implant Techniques”, and stated that: Passive Fitness is one of the requirements of the prosthesis supported by the implant, failure of which will result in complexity and problems in the treatment. This research has evaluated the Dimensional Register of Polyether and Polyvinyl Cyloxan Molding Materials in Different Techniques and the Splinted and Non-Splinted implants. 10 specimens for each group and a model for 4 implants of 4 mm diameter were made. Also forty trays were made of methacrylate composite and resin. Four groups including various molding materials (Splinted and Non-Splinted) were created. Upon completion of molding, the abutment was placed onto the implant analogs and the ball tops onto the abutments. The spacing of the ball tops from one another and also their spacing from the reference point were measured. The findings were analyzed by the SPSS 10 Software. ANOVA analysis was used to perform statistical analysis subsequent to variance homogeneity test. In case of variance homogeneity, the Tukey multi aspects comparison test, but otherwise, the Games-Howell test was conducted. The variance two-way analysis was used for comparison of the relationship between molding material and molding method. In the end, no significant statistical difference was noted between the quantity of the second and third implants and the first implant. As to the fourth implant, the difference in the length for the Splint group was less than that of the Non-Splint group (Seyedan et al., 2008).

In 2008, Mary P. Walker and et al, in a research titled “Precision of the Implant Cast as a function of the Molding Materials Viscosity Molding Techniques”, a master stainless steel model, with three copies of the implant for creating Type IV stone casts, was used. The master model moldings were made by using trays fastened at the level of the implant, with screwed copings of steel molding (indirect at the level of implant) or at the level of abutment with coupling plastic molding caps (direct/at level of abutment). In both techniques, the polyether molding material of heavy body or medium body was injected around the coping of the implant molding or abutment molding cap, and also the medium body material was poured onto tray. 20 casts together with 5 casts in each test group was made. A measuring microscope (with 001.0 mm precision was used for the measurement of the spacing inside the implant or inside the cast abutment. The precision of the cast based on the percentage of the difference among the measurements compared to the master cast was measured, the casts made by the indirect method and the steel molding copings were found to be more precise than the casts made by the direct method and the plastic molding cap. However, there are also problems with the direct Splint method which was told to be more precise, among others potential restoration in relation to polymerization contraction of the Splinting materials. Moreover, the open tray molds mostly cannot be used in the rear curve, because the patient cannot adequately open his mouth so that coping screws may access the screw location. As a result, the closed tray and indirect molding are being used with a higher frequency (Walker at al., 2008). In this research, the angles of the implants placement have not been mentioned.

In 2009, Rismanchian and Moniri Fard, in a research titled “A Review of the Articles: Implant Molding, Main Methods and Modifications”, they stated that one of the most genuine objectives in making a prosthesis based on implant was to make a superstructure with a Passive Fitness on the implant. It is necessary to prepare a precise molding of the implants to achieve such Passive Fitness. The aim of this article is to review the molding techniques that enhance the precision of the molding, and they will ultimately provide a passive superstructure. In comparison between the direct and indirect methods, numerous evaluations have been made. Many researchers believe that the indirect molding technique, compared to the direct technique, is of a lower precision. In the multi implants molding method, most researchers prefer the direct method, and they consider the indirect method as being restricted to use for the implant individual cases, but some others, despite significant statistical distinctions, clinically consider the two methods as acceptable, and deem the deviations as negligible. Also, as to multi implants cases, the connection of the implants to one another does not yield a better result in the final molding (Rismanchian and Monire Fard, 2009). In this research, the adopted statistical method and also the precision criterion for different moldings have not been pointed out.

In 2011, D. R. Prithviraj and et al, in a research named “A Review of Articles: Evaluation of the Implant Molding Precision by the Molding Materials and Different Techniques” stated that: By taking into account the implant capacities, nowadays more emphasis is made on the precision and brevity of the prosthesis. The first step to achieve such precision is the Passive Fitness. The progress made in the molding techniques, has caused the precise record of the implants position more complicated. In this research it was demonstrated that the precision in implant molding by use of Splint technique is higher than the Non-Splint technique. Meanwhile, no significant difference was noted between the Open Tray and Closed Tray techniques. But, further studies showed that in the cases of 4 implants and more, the Open Tray method is of a higher precision than the Closed Tray method (Prithviraj et al., 2011). In this research which serves to make a review on the articles, a number of references have been used, and the different types of methods and materials are well categorized. Yet, the statistical method adopted in this research had not been mentioned.

3. Research Methods

3.1. Research Hypotheses

This research includes an hypothesis as follows:

- If the Open Tray method is used in the molding with the polyether material, then the dimensional variations of the die will be reduced.

3.2. Statistical Society and Method of Measurement

a) Standard Model: A steel model was made with a diameter of 8 cm and height of 3 cm, in which there were 3 grooves to accommodate the implant including 3 implants (exterior hex), such that the spacing of the two angled implants from one another was 5 cm, and from the central implant was 3.5 cm. The central implant was placed perpendicular to the cast level, while the other implant nearness or farness from the central implant was 25.

b) Number of specimens: The number of specimens for each method of molding was 15.

c) Method of specimen selection: It is target oriented.

3.3. Research Variables

- ✓ Particular target variable 1: Laboratory model and specifying the dimensions and type of molding.
- ✓ Particular target variable 2: Dimensions after molding.
- ✓ Dependent variable: Dimensional variations.
- ✓ Independent variable: Splint and Non-Splint Molding Methods.
- ✓ Involved variables: Molding material, gypsum, water, environment temperature, molding pressure, setting time, gypsum cast time, and wash volume.

Table 1 below shows the tools, unit, and scale for measurement of the research variables.

Table 1: Tools, Unit, and Scale for Measurement of Research Variables

Variable Name	Measurement Tool	Measurement Unit	Measurement Scale

Molding Material	**Observation & As per Factory Instruction**	**-**	**Qualitative-Nominative**
Dimensional variations	**Electronic Microscope**	**Micron**	**Quantitative-Continuous**
Type of Gypsum	**Observation & As per Factory Instruction**	**-**	**Qualitative-Nominative**
Setting Time	**Observation & As per Factory Instruction**	**Second**	**Quantitative-Continuous**
Molding Technique	**Observation**	**Open & Closed**	**Qualitative-Nominative**

4. Result

Research was performed by experimental-laboratory method. Research was conducted on 15 specimens and on 3 systems of implants, tantamount to 45 specimens in each group, and also with 6 points (A, B, C, D, E, F). First, a steel model with a diameter of 8 cm, height of 3 cm was made in which 3 grooves were anticipated to accommodate the implant including 3 implants (exterior hex), such that the spacing of the two angled implants from one another was 5 cm and from the central implant was 3.5 cm. The central implant was placed perpendicular to the cast level, while the other implant nearness or farness from the central implant was 25. In order to make the master cast, Velmix gypsum type 4 and a vacuumed mixer were used. The entire implant was hardened by Ciano Acrylate, and all the work was completed by a performer. Trays were prepared from the polymerized acryl material and the visible light, and they were polymerized for 6 minutes. Trays were trimmed and holed so that to increase the hardening of the molding material. Meanwhile, the master cast had two pilot holes to fit the particular tray by Open Tray method. In this research, molding is performed by two methods of Splint Non-Splint, and both by Open Tray technique. In the former method (Splint), the implants and the Dural acryl are splinted on the model in the laboratory, and they are molded by the Open Tray technique. In the latter method (Non-Splint), 3 implants were made by Open Tray method from the model in the laboratory.

Trays were filled with polyether. They were placed on the master cast, the extra material was removed from the Open Tray by a finger to expose the Pin and before separation the molding material was left to be polymerized for 10 minutes. As to Open Tray technique, the pilot pins were loosened and removed by a hex-driver. Then, the tray was separated from the master cast, and the molding copings were remained in the mold, while the implant analog of the lower two parts are connected.

The mold was examined. When such errors as air bubble and molding material were noted at the connection location of coping and analog, it was repeated. Then, Velmix gypsum Type 4 was prepared based on the factory instruction. Upon hardening of the gypsum during 1 hour, the casts were trimmed and given codes, and by a clamp they were placed on the mantining plate to be measured simultaneously, and a stylus with a fine and thin top was used to record a multi axes coorditor (x-y-z) on the upper level of hex implant and on the cast base. The stylus top was placed in the center of the implants hex, and it was measured against 6 corners of the hex and in view of the 3 planes (x-y-z). Then, the various vector calculations within the degrees of the implant angles in the master cast and duplicated cast were made and determined. The statistical analysis adopted was the T. Test.

4.1. Model Evaluation and the Findings

Research on 15 specimens and on 3 implant systems, tantamount to 45 specimens in each group, and also with 6 points (A, B, C, D, E, F) was conducted. Range of dimensional variations of implant location transfer in Non-Splint method was 170.2±68.4, and in Splint group was 169.8±71.7, which in the experimental group it was 7 µ % less or more, and the T-Test demonstrated that such difference was not statistically significant. Meanwhile, C.V in the proof group was 40.2%, and in the Splint group was 42.2%. In figure (1), the dimensional variations are shown as per Splint and by separate angles, and T-Test demonstrated that in all those angles, the Splint difference was not statistically noteworthy. The results of the T-Test are shown in the Table (2).

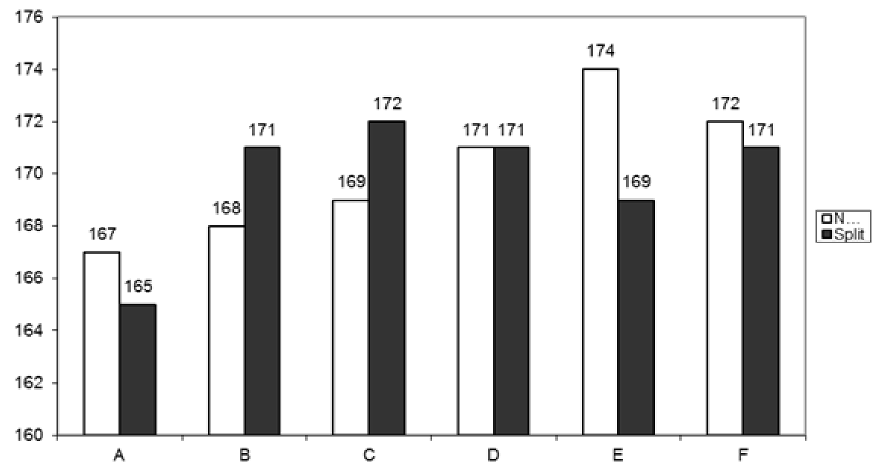


Figure 1: Dimensional variations in the Specified Points

Table 2: Dimensional variations Shown as per the Splint and Non-Splint Methods

Test Result	Splint		Non Splint		Method
	C.V	Range	C.V	Range	Group
P < 0.9	42.7	165 ± 70.5	40.8	167 ± 68.2	A (n=45)
P < 0.9	41.6	171 ± 71.2	40.6	168 ± 68.2	B (n=45)
P < 0.9	42.4	172 ± 72.9	40.1	169 ± 67.8	C (n=45)
P < 0.99	42.7	171 ± 73	39.4	171 ± 67.3	D (n=45)
P < 0.8	41.2	169 ± 69.6	40.2	174 ± 69.9	E (n=45)
P < 0.9	42.8	171 ± 73.2	40.1	172 ± 69	F (n=45)

The 3D distance (x-axis, y-axis, and z-axis) measured were A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F [Figure 13]. Various studies have been carried out using lesser number of implants (2 or 4). Very few studies have been performed with maximum number of implants. In this study, seven implants were used to simulate a clinical condition of severe atrophic edentulous maxilla requiring fixed implant-supported prosthesis. Hence, the maximum interimplant distances (A–E, B–G, C–F, D–F, D–E, D–G, and A–F) were made possible to ensure the better reliability in the results of the study resulting in making this study more clinically significant. All the measurements were recorded three times by the same operator, and the mean value was calculated.

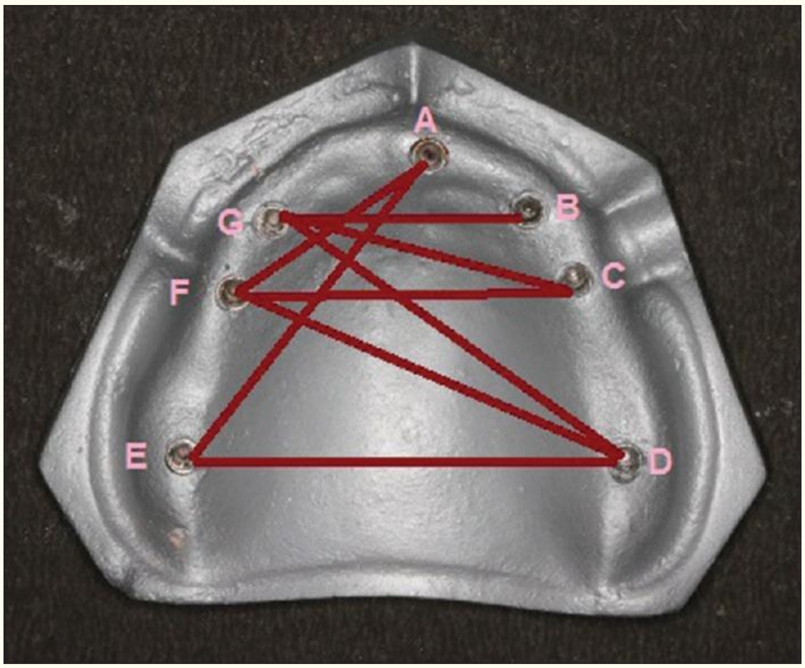


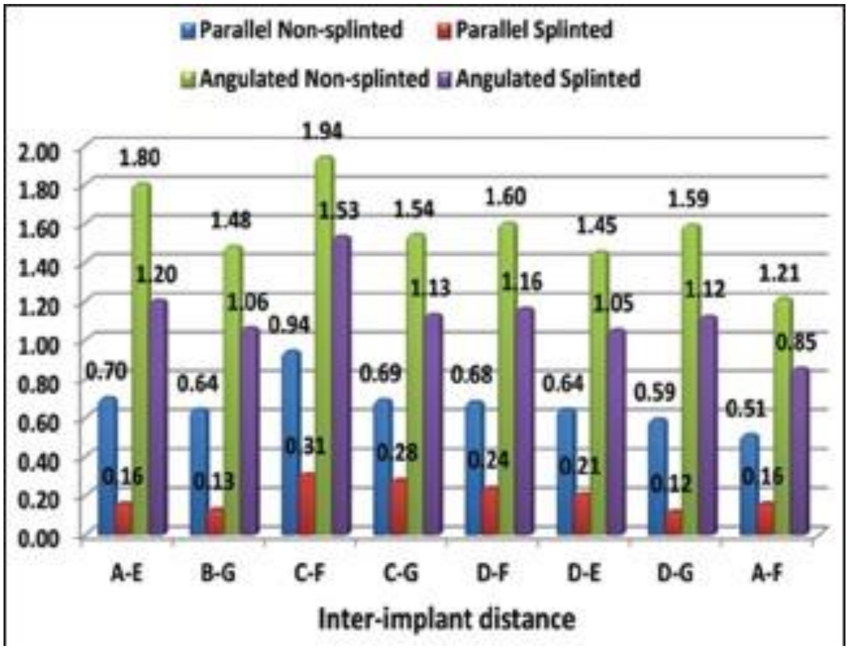
Figure 2 : Interimplant distances measured

Table 3 and Graph 1 depicts the summarization of the mean difference and standard deviation of interimplant distances such as A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F compared from control values on master models. A significant difference (P < 0.001) was found among the four subgroups. The mean difference was found to be maximum in angulated splinted group (Subgroup 2NS; 1.80, 1.48, 1.94, 1.54, 1.60, 1.45, 1.59, and 1.21), followed by angulated splinted (Subgroup 2S; 1.20, 1.06, 1.53, 1.13, 1.16, 1.05, 1.12, and 0.85), parallel nonsplinted (Subgroup 1NS; 0.70, 0.64, 0.94, 0.69, 0.68, 0.64, 0.59, and 0.51), and parallel splinted (Subgroup 1S; 0.16, 0.13, 0.31, 0.28, 0.24, 0.21, 0.12, and 0.16) groups.

Table 3 : Subgroup comparison of mean difference and standard deviation

Interimplant distance	**Mean difference and SD**	**Subgroup 1NS**	**Subgroup 1S**	**Subgroup 2NS**	**Subgroup 2S**
A-E	Mean difference	0.70	0.16	1.80	1.20
	SD	0.39	0.27	0.32	0.22
B-G	Mean difference	0.64	0.13	1.48	1.06
	SD	0.36	0.40	0.56	0.23
C-F	Mean difference	0.94	0.31	1.94	1.53
	SD	0.43	0.30	0.29	0.39
C-G	Mean difference	0.69	0.28	1.54	1.13
	SD	0.37	0.39	0.36	0.27
D-F	Mean difference	0.68	0.24	1.60	1.16
	SD	0.35	0.44	0.58	0.36
D-E	Mean difference	0.64	0.21	1.45	1.05
	SD	0.11	0.18	0.18	0.34
D-G	Mean difference	0.59	0.12	1.59	1.12
	SD	0.14	0.21	0.37	0.25
A-F	Mean difference	0.51	0.16	1.21	0.85
	SD	0.14	0.57	0.25	0.37

SD: Standard deviation, S: Splinted, NS: Nonsplinted



Graph 1 : Inter sub group comparison of mean difference

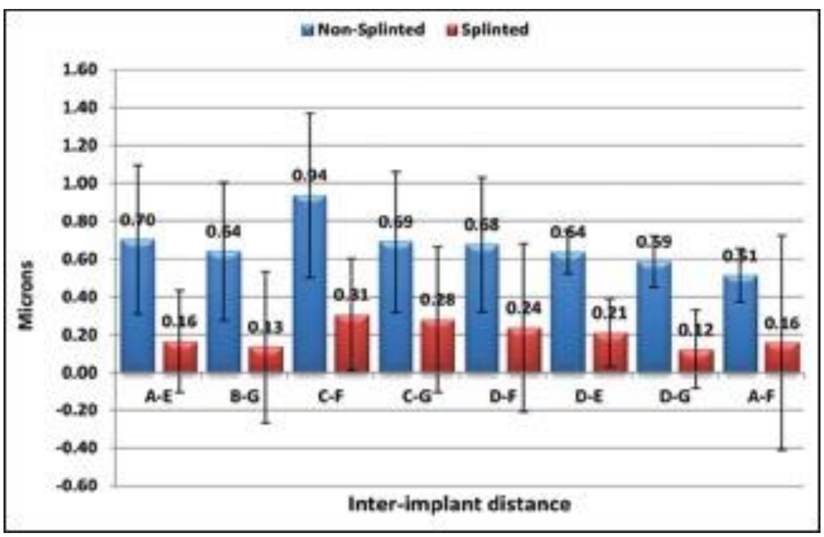
In Table 4 and Graph 2, the intragroup comparison of mean difference of interimplant distances such as A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F among parallel splinted (Subgroup 1S) and parallel nonsplinted (Subgroup 1NS) groups was done using the unpaired t-test. The mean difference was found to be significantly more in parallel nonsplinted (Subgroup 1NS; 0.70, 0.64, 0.94, 0.69, 0.68, 0.64, 0.59, and 0.51) in comparison to parallel splinted (Subgroup 1S) groups.

Table 4 : Unpaired t-test for intragroup comparison between parallel nonsplinted (Subgroup 1 nonsplinted) and parallel splinted (Subgroup 1 splinted) groups

Model with parallel implants	**Group**				**Difference**	**t-test**	**P**
	Subgroup 1NS		**Subgroup 1S**				
	Mean difference	**SD**	**Mean difference**	**SD**			
A-E	0.70	0.39	0.16	0.27	0.54	2.702	0.007*

Model with parallel implants	Group				Difference	t-test	P
	Subgroup 1NS		Subgroup 1S				
	Mean difference	SD	Mean difference	SD			
B-G	0.64	0.36	0.13	0.40	0.51	3.639	<0.001*
C-F	0.94	0.43	0.31	0.30	0.63	2.935	0.001*
C-G	0.69	0.37	0.28	0.39	0.41	3.690	<0.001*
D-F	0.68	0.35	0.24	0.44	0.44	3.675	<0.001*
D-E	0.64	0.11	0.21	0.18	0.43	3.636	<0.001*
D-G	0.59	0.14	0.12	0.21	0.46	3.586	<0.001*
A-F	0.51	0.14	0.16	0.57	0.36	2.513	0.025*

*Significant difference (P<0.05). SD: Standard deviation, S: Splinted, NS: Nonsplinted



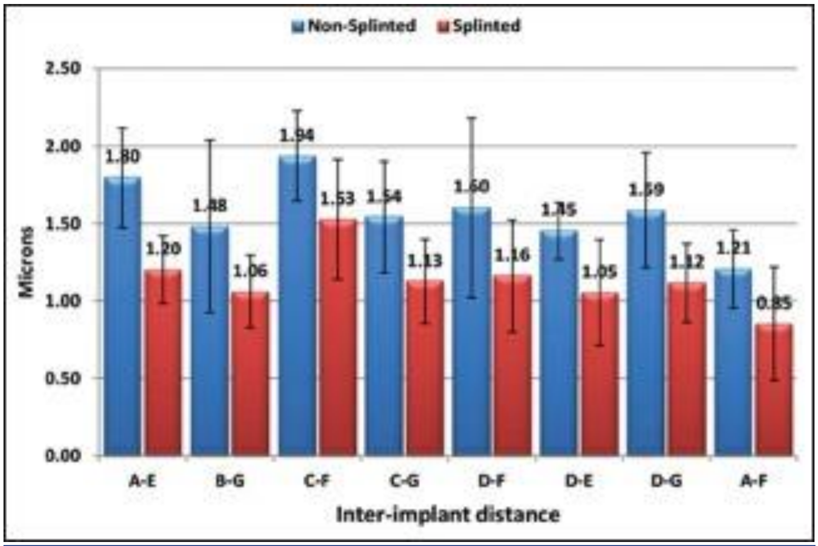
Graph 2 : Intragroup comparison of mean difference with standard deviation between parallel nonsplinted (Subgroup 1NS) and parallel splinted (Subgroup 1S) groups

In Table 5 and Graph 3, intragroup comparison of mean difference of interimplant distances such as A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F among angulated nonsplinted (Subgroup 2NS) and angulated splinted (Subgroup 2S) groups was done using the unpaired t-test. The mean difference was found to be significantly less in angulated splinted (Subgroup 2S; 1.20, 1.06, 1.53, 1.13, 1.16, 1.05, 1.12, and 0.85) in comparison to angulated nonsplinted (Subgroup 2NS; 1.80, 1.48, 1.94, 1.54, 1.60, 1.45, 1.59, and 1.21) groups.

Table 5 : Unpaired t-test for intragroup comparison between angulated nonsplinted (Subgroup 2 nonsplinted) and angulated splinted (Subgroup 2 splinted) groups

Model with angulated implants	**Group**				**Difference**	**t-test**	**P**
	Subgroup 1NS		**Subgroup 1S**				
	Mean difference	**SD**	**Mean difference**	**SD**			
A-E	1.80	0.32	1.20	0.22	0.59	4.843	0.001*
B-G	1.48	0.56	1.06	0.23	0.42	2.196	0.041*
C-F	1.94	0.29	1.53	0.39	0.41	2.679	0.016*
C-G	1.54	0.36	1.13	0.27	0.42	2.914	0.009*
D-F	1.60	0.58	1.16	0.36	0.44	2.033	0.037*
D-E	1.45	0.18	1.05	0.34	0.40	3.253	0.004*
D-G	1.59	0.37	1.12	0.25	0.47	3.314	0.004*
A-F	1.21	0.25	0.85	0.37	0.35	2.514	0.022*

*Significant difference (P<0.05). SD: Standard deviation, S: Splinted, NS: Nonsplinted



Graph 3 : Intragroup comparison of mean difference with standard deviation between angulated nonsplinted (Subgroup 2NS) and angulated splinted (Subgroup 2S) groups

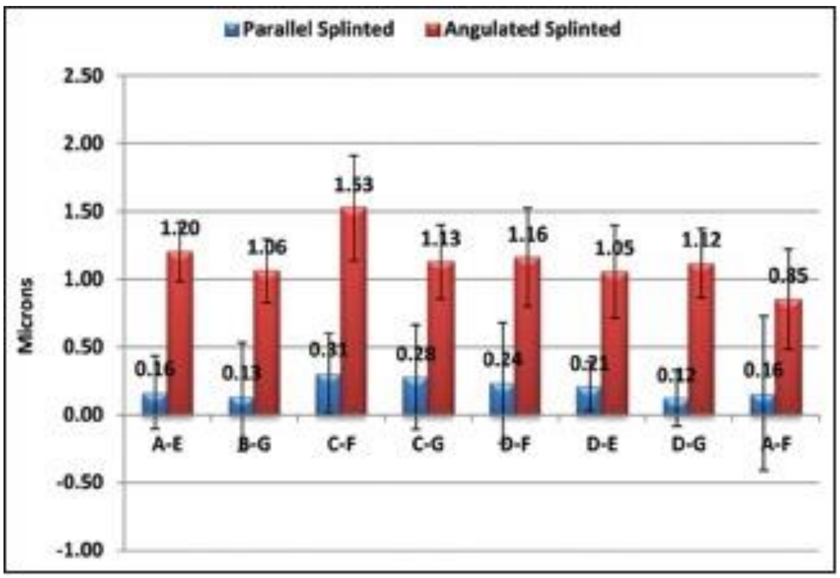
Table 6 and Graph 4, depicts the comparison of mean difference of interimplant distances such as A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F among parallel splinted (Subgroup 1S) and angulated splinted (Subgroup 2S) groups using the unpaired t-test. It was evaluated that the mean difference was significantly less among parallel splinted (Subgroup 1S; 0.70, 0.64, 0.94, 0.69, 0.68, 0.64, 0.59, and 0.51) in comparison to angulated splinted (Subgroup 2S; 1.80, 1.48, 1.94, 1.54, 1.60, 1.45, 1.59, and 1.21) groups.

Table 6 : Unpaired t-test for intergroup comparison for splinted impression technique

Inter implant distance	Subgroup 1S		Subgroup 2S		Mean difference	t-test	P
	Mean difference	SD	Mean difference	SD			
A-E	0.70	0.39	1.80	0.32	−1.09	−6.826	<0.001*
B-G	0.64	0.36	1.48	0.56	−0.84	−3.994	0.001
C-F	0.94	0.43	1.94	0.29	−1.00	−6.068	<0.001*
C-G	0.69	0.37	1.54	0.36	−0.85	−5.200	<0.001*
D-F	0.68	0.35	1.60	0.58	−0.93	−4.300	<0.001*

Inter implant distance	Subgroup 1S		Subgroup 2S		Mean difference	t-test	P
	Mean difference	SD	Mean difference	SD			
D-E	0.64	0.11	1.45	0.18	−0.82	−11.905	<0.001*
D-G	0.59	0.14	1.59	0.37	−1.00	−8.026	<0.001*
A-F	0.51	0.14	1.21	0.25	−0.69	−7.594	<0.001*

*Significant difference (P<0.05). SD: Standard deviation, S: Splinted



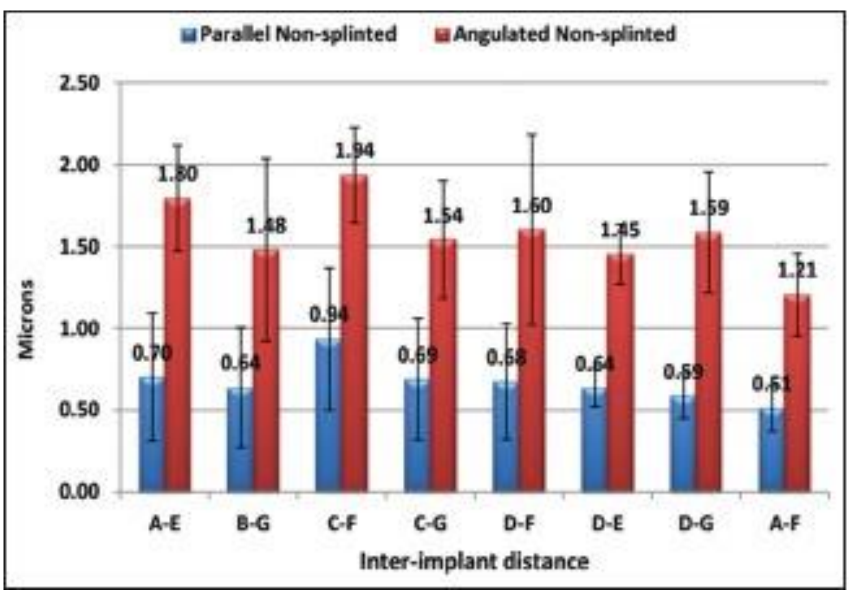
Graph 4 : Comparison of mean difference with standard deviation for splinted impression technique

In Table 7 and Graph 5, the comparison of mean difference of interimplant distances such as A–E, B–G, C–F, C–G, D–F, D–E, D–G, and A–F among parallel nonsplinted (Subgroup 1NS) and angulated nonsplinted (Subgroup 2NS) groups was done using the unpaired t-test. The mean difference was found to be significantly less among parallel nonsplinted (Subgroup 1NS; 0.70, 0.64, 0.94, 0.69, 0.68, 0.64, 0.59, and 0.51) in comparison to angulated nonsplinted (Subgroup 2NS; 1.80, 1.48, 1.94, 1.54, 1.60, 1.45, 1.59, and 1.21) groups.

Table 7 :Unpaired t-test for intergroup comparison for nonsplinted impression technique

Interimplant distance	Subgroup 1NS		Subgroup 2NS		Mean difference	t-test	P
	Mean difference	SD	Mean difference	SD			
A-E	0.70	0.39	1.80	0.32	−1.09	−6.826	<0.001*
B-G	0.64	0.36	1.48	0.56	−0.84	−3.994	0.001
C-F	0.94	0.43	1.94	0.29	−1.00	−6.068	<0.001*
C-G	0.69	0.37	1.54	0.36	−0.85	−5.200	<0.001*
D-F	0.68	0.35	1.60	0.58	−0.93	−4.300	<0.001*
D-E	0.64	0.11	1.45	0.18	−0.82	−11.905	<0.001*
D-G	0.59	0.14	1.59	0.37	−1.00	−8.026	<0.001*
A-F	0.51	0.14	1.21	0.25	−0.69	−7.594	<0.001*

*Significant difference (P<0.05). SD: Standard deviation, NS: Nonsplinted



Graph 5 : Comparison of mean difference with standard deviation for nonsplinted impression technique

5. Conclusion

The results of the research have shown that from the dimensional variations point of view, there is no significant difference between the Splinted Open Tray and Non-Splint Open Tray methods. The results of this research, despite certain differences in the method of study and the measurement tool, correspond to the researches made by the other researchers on these grounds (Rismanchi and Moniri Fard, 2009; Walker et al., 2008; Carr, 1991; Daoudi, 2001). The present research has established that the dimensional variations in the implants of 25 degrees location farness are not statistically significant in both two molding methods. Such result contradicts certain researches already made. Some references have evaluated significant difference in the Splint method (Seyedan et al., 2008; Prithviraj et al., 2011; Heather et al., 2007). But, in this research, and in the Splint and Non-Splint molding methods, statistically there is no significant difference in the dimensional variations. The reason for such finding is that the Non-Splint Open Tray method is more simple, and it is due to the precision of the performer in carrying out of the molding technique, and that the Splint method is time consuming. Given the present results in this regard, the preference of either Splint or Non-Splint method is less shown; the factor of precision by the performer in the application of the methods was more effective than any other factors in obtaining the results.

Dr. Kaveh Seyedan and et al (2008), have considered the Passive Fitness as one of the requirements of the prosthesis supported by the implant. They noted significant statistical difference between the Splint and the Non-Splint methods, such that the Splint technique caused less error than the Non-Splint technique. But, in the present research, the implants placement angles have not been mentioned, and 4 implants were involved in the research trial model.

Mr. Vigolo and et al (2003), considered the connection of the molding copings by Dural Acrylic Resin, as more effective vs Non-Splint Open Tray method due to reduced dimensional variations; but for analysis of their specimens, they used projector profile method, which in effect provides for the 3-D measurement, and not the range of the reduction in the measured dimensions in those two studied dimensions are sufficient.

Dr. Prithviray and et al (2011) stated that the Splint method is of a higher precision than the Non-Splint method, nevertheless in this research, the methodology and number of specimens is different from those of this research.

In a research made by L. M. Carbal et al (2007), the different implant molding techniques were examined to decide precision of their dimensions, and the obtained results were compared against the standard technique. In this research, also a significant relationship was noticed between the Splint and Non-Splint methods.

There are various methods as to the tools and measurements of the produced specimens, which should have higher precision than the molding precision. Accordingly, in the present research, the best measuring equipment in the smallest dimensions and in 3-D have been used, among one of their most precise ones is usage of Coordinating measuring tools, such as CMM (Sazgara & Nahidi, 2008; Seyedan et al., 2008). In this research, from the aspect of implant angle between being Straight and Angulated, a significant difference was noted. The angulated implants during removal of the mold from the mouth, apply substantial stresses onto the molding materials which may contribute to stabilized changes in the molding materials.

What should be taken into account while comparing the results of the experimental and semi experimental researches, is the various methods of researches that the researchers have adopted, and such difference in in the research method, including the design of experimental models of measuring devices within the analysis intervals against the various reference points, and the molding methods, makes the precise comparison of the results rather difficult, and conduct of researches inside the mouth (In Vivo) on these grounds and to increase the clinical generalization, and to achieve the most precise and most simple method of molding in the dental implants appears imperative.

In a research launched by J. Heather et al (2007), the precision shown by the two molding techniques of Open Tray and Closed Tray were not so much different ($P = 0.22$), and the implant angle and number were different from the average deviation angle, but not so much to be easily interpreted ($P > 0.001$). In this research, various angles of 5˚, 10 ˚, and 15 ˚ were used, but the time of measurement after pouring of the casts and the type of the software had not been specified.

In the research made by Dr. Daudi, M. Firas and et al (2001), the precision in the four implant molding processes by two methods of direct and indirect, with the molding materials of polyether and polyvinyl Cyloxan were examined, which in this research the indirect method was deemed as preferred. It has to be pointed out that the direct precise software was SAS.

In the research made by Dr. P. Walker, Mary et al, (2008), it was demonstrated that the casts made by the closed trays and indirect method with the steel copings at the level of the implant, are more precise than the casts made by the closed trays and direct method with the usage of plastic caps at the abutment level.

In the consequence, it shall be pointed out that with due regard to the restrictions of this research, the Non-Splint molding method in the angled implants, did not show significant effect in reducing the dimensional variations by the Splint method, and given the ease of performance and reduced time of molding, the Non-Splint Open Tray method is recommended.

Suggestions

1) To conduct more researches on these grounds to assess the possibility of enhancing the dimensional precision for the final cast, and to approach the inter-mouth conditions to boost clinical generalization.

2) To hold coordination meetings among the pertinent engineering companies and the dentist, by the study and compilation of the prior data after the work performance.

3) To use new molding materials arrived in the market, and to compare the range of dimensional variations of different materials.

4) Given the use of Stone gypsum in the casting of implant molds, to make a comparison between the range of dimensional variations between the castings with two types of gypsum, i.e. Stone and Velmix.

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