ORIGINAL RESEARCH

Efficacy of different splinting material with the open tray impression technique: An invitro analysis

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ABSTRACT

Introduction: Splinting with impression plaster, resin or bite registration material are recommended for maintaining a more accurate inter implant relationship although the accuracy of the techniques in yielding accurate casts is controversial. The purpose of this in vitro study was to evaluate the effect of dimensional stability of conventionally used and advanced splinting materials on the accuracy of master casts. **Materials & Methods:** A reference wax model with four implants Rp-10mm was positioned in the mandibular ridge at an angulation of 0^0 in the anterior region and at an angulation of 45^0 in the posterior region using an All on 4 guide for proper orientation. A total of 8 master cast were obtained, 4 for each group and only one model was obtained from each impression. A profile projector was used to measure the linear distances. **Results:** Splinting the impression coping with autopolymerizing resin, adequate polymerization time and compensation procedure before impression was found to be statistically the most accurate method of splinting with its inter-implant distances showing less variation from the reference model. **Discussion & Conclusion:** The accuracy of the master cast obtained using direct impression technique with different splinting materials which has yielded positive results especially in relation to the use of auto-polymerizing pattern resin as it showed less amount of variation from the reference model when compared to polyvinyl siloxane so it can be more suitably used as the splinting material. After considering the various aspects of the present study and co-relating the results with the literature, it is concluded that improved accuracy of definitive cast was achieved with the use of autopolymerising resin.

Keywords: Open Tray Impression, Splinting, Pattern Resin, Polyvinyl Siloxane

INTRODUCTION

A new era in restorative clinical dentistry began in 1950 with the introduction of dental implants as a restorative option. Subsequently dental implants came to the forefront in dentistry and became a standard of care for oral rehabilitation. Although conventional dental implants have demonstrated long term success rates of around 88% after an observation time of 12.2 to 23.5 years, but this protocol of delaying the replacement of the missing tooth, associated function and aesthetics, resulted in severe compromise of hard and soft tissue architecture owing to rapid bone resorption after tooth loss.[1,2]

The success of an implant-supported restoration is related to the quality of the prosthetic restoration as well as its integration into the surrounding tissues. In cases of compromised teeth, the immediate implantation consists in placing an implant immediately into tooth extraction site.[3] The use of dental implants has revolutionized prosthodontics and the fixed treatment options that can be offered to patients. High survival rates and long- term predictability for clinically loaded endosseous implants have been consistently reported resulting in one of the most successful treatment modalities in dentistry.[4,5]

To ensure maximum accuracy, some authors emphasized the importance of splinting impression copings together intra-orally before making an impression. Various materials such as acrylic resin, dental plaster, bite registration silicone, and polyether (PE) have been used as splinting materials with varying degrees of accuracy.[6,7] With regard to splinting the impression copings, there are many

controversies that exist since Branemark et al emphasized the importance of splinting impression copings together before registration of multiple implant impression. The common practice of joining the direct transfer copings with acrylic resin is an attempt to stabilize the copings against rotation during fixture or abutment analog fastening, control the relationship between implants in a rigid fashion However, various literature studies showed no significant differences between the values obtained with acrylic resin splinted versus unsplinted groups in impression technique.[6,8,9]

Among the direct impression techniques, both splinting and non-splinting have been advocated for accurate impressions. Splinting with impression plaster, resin or bite registration material are recommended for maintaining a more accurate inter implant relationship although the accuracy of the techniques in yielding accurate casts is controversial.[10,11] The purpose of this in vitro study was to evaluate the effect of dimensional stability of conventionally used and advanced splinting materials on the accuracy of master casts.

MATERIALS & METHODS

A reference wax model with four implants Rp-10mm was positioned in the mandibular ridge at an angulation of 0^0 in the anterior region and at an angulation of 45^0 in the posterior region using an All on 4 guide for proper orientation. The reference model mimics a mandibular implant-supported overdenture situation. Three stoppers, one in the anterior and two in the posterior region were made in the land area of the mandibular reference model to ensure the proper orientation of the impression trays. The reference model is then fabricated in heat cure acrylic resin.

Using the reference model fabricated in heat cure as a preliminary cast, a spaced primary cast was made. In order to obtain uniform spacer, 3 mm even spacer was adapted onto the reference modelusing modelling wax and the impression was made and spaced primary cast was obtained. Eight custom trays (four per group) with windows in the anterior region were made using light cure acrylic resin sheet of 2 mm in thickness. All the custom trays are uniformly spaced and are cured in a light curing unit using visible light of wavelength 32^0-55^0 nm for a period of 5 minutes. To ensure dimensional stability of custom tray, the trays are left undisturbed for 24 hours prior to the impression making. A set of twelve custom trays were made (four per group).

The "All on 4"multiunit abutments of 17^0 angulation in the anterior region and 30^0 angulation in the posterior region are screwed to the implant body. The open tray impression copings are then screwed to the multi-unit abutments at 15 Ncm torque.The open tray copings were primarily splinted with dental floss.

In Group A, Autopolymerizing resin65 (GC pattern resin, Osaka, Japan) was mixed in the ratio of 2 g–1 ml. When the resin reached the dough stage, it was packed around the impression posts and the dental floss. The splint was allowed to polymerize for 4 minutes. The splint was sectioned in between the impression posts using a separating disc to relieve the stresses caused by polymerization shrinkage. The cut sections were joined using the same resin by applying it using brush bead method. This was again allowed to polymerize for 4 min. The impression copings, custom tray, and the splint were coated with polyvinylsiloxane adhesive and allowed to dry for 15 min.

In Group B, Polyvinylsiloxane was used to splint the impression copings. The two components of polyvinylsiloxane (putty) areincorporated by hand kneading until uniform colour is achieved. This should be accomplished in 45 seconds. It was then packed around the impression posts and the dental floss and was splinted together. The splint was allowed to set for about 5 minutes. The impression copings, custom tray, and the splint were coated with polyvinylsiloxane adhesive.

The light body polyvinylsiloxane was machine mixed and dispensed into a penta elastomer syringe. It was syringed around the impression copings to avoid impression defects around the copings while the putty consistency of polyvinylsiloxane is loaded onto the custom tray. The tray was then carried onto the reference model immediately and the impressionmade. It was made sure that the tray is seated completely in the three stops that were made in the reference model to ensure complete seating and proper positioning of the custom tray.

The impression was allowed to set for 6 min as per the manufacturer's recommendation. The screws of the impression posts were unscrewed and the impression removed from the reference model. A total of four impressions were made in each group in a similar manner. The abutment replica was fastened on to the impression copings and the impressions were poured using Type IV gypsum product. A total of 8 master cast were obtained, 4 for each group and only one model was obtained from each impression.

A profile projector was used to measure the linear distances. The pouring carrier was secured in the holder of the device and its posterior corner was set parallel to the axis movement of the machine. Each cast was placed on it and maintained in position by means of three stoppers as previously described. Such a profile projector was provided with a screen with horizontal and vertical reference lines to allow to adjust all models to identical standardized positions, in order to assure that the copings of all casts were at the same level during the measurements.

The light source of the device projected a x10 magnified image of the cast to be measured onto a screen in the form of a shadow, so that the sharp edges of the projected silhouetted of the transfer copings were used as the reference points of measurement. The profile projector was provided with an integrated digitaldisplay counter and calibrated to

an accuracy of +0.5um. Four distances were measured on the control acrylic resin models and on the definitive study casts (1) D1 – the distance between the external sharp edges of the projected silhouetted form of the most anterior and most posterior right impression copings (1 and 2). (2) D2 – the distance between the internal sharp edges of the projected silhouetted form of the most anterior left and right impression copings. (2 and 3). (3) D3 – the distance between the external sharp edges of the projected silhouetted form of the most posterior left and right impression copings. (1 and 4). (4) D4 – the distance between the internal sharp edges of the projected silhouetted form of the most posterior left and right impression copings. (1 and 4).

Statistic Analysis: The measurements were tabulated and statistically analyzed and the results were obtained. A factorial analysis of variance using ANOVA was used for statistical analysis and $P < 0.05$ was considered as significant.

RESULTS

The linear inter-implant distances in the master cast obtained by splinting the impression copings using Auto-polymerised resin (pattern resin) and Polyvinylsiloxane (putty consistency) were compared with the interimplant distance in the reference model using a profile projector and were subjected to statistical analysis. A reference acrylic resin model and a total of 8 master casts was used in the study out of which, 4 master casts were obtained by splinting the impression copings with Auto-polymerised pattern resin and 4 master casts were obtained by splinting the impression copings with Polyvinylsiloxane in putty consistency.

The acrylic resin model and the master casts were assessed using a profile projector to determine the inter-implant distances. Four distances were measured on the control acrylic resin models and on the definitive study casts: D1 – the distance between the external sharp edges of the projected silhouetted form of the most anterior and most posterior right impression copings (1 and 2), D2 – the distance between the internal sharp edges of the projected silhouetted form of the most anterior left and right impression copings. (2 and 3), D3 – the distance between the external sharp edges of the projected silhouetted form of the most posterior left and right impression copings. (1 and 4), D4 – the distance between the internal sharp edges of the projected silhouetted form of the most posterior left and right impression copings. (1 and 4).

One reading each was taken for the inter-implant distances inthe reference model and for all the master casts obtained by splinting with Auto-polymerised pattern resin and Polyvinylsiloxane in putty consistency. Further, the mean of the inter-implant distances were calculated and this reading was taken as the inter-implant distance for that particular group and compared with the inter-implant distance of the reference model. The results were then subjected to statistical analysis.

Mean minimum, maximum and standard deviation of the inter-implant distances of the reference group and three splinting groups are listed in Table 1, 2, 3 and 4. From this data it was found that the inter-implant distances in relation to the use of autopolymerizing pattern resin showed less amount of variation from the reference model when compared to Polyvinyl siloxane (putty consistency).

Table 1: Difference in the mean value between the different splinting groups from the reference model at D1 using ANOVA

Distance	Model group	Mean	± SD	F value	P value
D1	Reference model	18.94	086	.72	.73
	GC pattern resin	18.10	531		
	Polyvinylsiloxane	18.05	723		

F value and P value obtained by One way analysis of variance

*- Non significant – p value < 0.05 is significant

Table 2: Difference in the mean value between the different splinting groups from the reference model at D2 using ANOVA

Distance	Model group	Mean	± SD	F value	P value
D2	Reference model	11.86	057	.61	.79
	GC pattern resin	11.83	089		
	Polyvinylsiloxane	11.99	096		

Table 3: Difference in the mean value between the different splinting groups from the reference model at D3 using ANOVA

Distance	Model group	Mean	± SD	F value	P value
D3	Reference model	41.53	139	4.12	.087
	GC pattern resin	41.47	164		
	Polyvinylsiloxane	41.030	107		

Table 4: Difference in the mean value between the different splinting groups from the reference model at D4 using ANOVA

Distance	Model group	Mean	± SD	F value	P value
D4	Reference model	31.75	154	3.34	.06
	GC pattern resin	31.69	186		
	Polyvinylsiloxane	31.25	115		

Splinting the impression coping with autopolymerizing resin, adequate polymerization time and compensation procedure before impression was found to be statistically the most accurate method of splinting with its inter-implant distances showing less variation from the reference model.

DISCUSSION

Dental implants have been proven successful in the treatment of edentulism. Applications of implants in dentistry include restoration of partially edentulous, single-tooth, and implant overdenture treatments. Most of the researchers reported the open-tray pick-up technique to be more precise and predictable than the closed tray technique using repositionable copings. computer-aided design-computer-aided manufacturing technologies have been developed to fabricate a complete arch substructure for a fixed, screw-retained implant-supported prosthesis. [12,13]

Osseointegrated implants have provided alternative treatments option to conventional prosthesis for patients who were partially and completely edentulous and achieved predictable and favorable long-term results. An accurate and passive fit of an implant framework prosthesis, as well as the successful surgical operation is suggested as one of the critical requirements for long-term implant success.[14]

Presence of occlusal loads and torquing stresses on the various portion of implant elements causes problems related to poor fit of frameworks connected to implant and may also lead to marginal bone loss and failure of implants, as well as in relation to mechanical problems as loosening of screws and fatigue fractures of implant components.[15,16]

In regard to splint the impression copings, there are many controversies exist since Branemark *et al*. emphasized the importance of splinting impression copings together before registration of multiple implant impression. The common practice of joining the direct transfer copings with acrylic resin is an attempt to stabilize the copings against rotation during fixture or abutment analog fastening, control the relationship between implants in a rigid fashion. However, varies literature studies showed no significant differences between the values obtained with acrylic-splinted versus unsplinted groups in impression technique.

In this study a reference model with four implant analogues was used since the minimum number of implant suggested to support a fixed implant supported complete denture is four. This is an attempt made to compare the reliability of autopolymerizing pattern resin and Polyvinylsiloxane in putty consistency as the splinting material. Light body and putty consistency polyvinylsiloxane was used as the impression material.

From these data obtained, the inference of the study depends on the application of polyvinylsiloxane adhesive, polyvinylsiloxane impression material, rigidity of the splinting materials, tolerance between implant components and torque employed during fastening of the implant replica and could determine, either individually or collectively the extent of distortion.

In a study conducted by Sang-Jik Lee, David Assif and Ravi Shankar on the accuracy of implant impression technique and the effect of splinting materials and methods, splinting the impression copings with autopolymerizing resin following compensation of polymerization shrinkage can enhance the accuracy of master cast and can be used as an effective splinting material for implant impression procedure was found to be statistically the most accurate method of splinting. The results obtained in the present study can be co-related to the results of the above mentioned study where splinting the impression copings with auto-polymerising resin showed better accuracy when compared to polyvinylsiloxane.

Conclusion

The accuracy of the master cast obtained using direct impression technique with different splinting materials which has yielded positive results especially in relation to the use of auto-polymerizing pattern resin as it showed less amount of variation from the reference model when compared to polyvinyl siloxane so it can be more suitably used as the splinting material. After considering the various aspects of the present study and co-relating the results with the literature, it is concluded that improved accuracy of definitive cast was achieved with the use of autopolymerising resin.

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