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Original Article

Effect of Different Type of Provisional Restorative Material on Micromovement of Immediate loading Implant

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ABSTRACT

Aims. *This in vitro study was to evaluate the effect of three type provisional restorative material on micromovement of immediate loading implant.* ***Methods***. *Thirty samples of provisional bridges were fabricated using three different restorative materials A- Resinous CAD/CAM. B- Dual cure composite .C- Conventional heat cure resin, fixed-fixed bridge cemented over implant by zinc oxide eugenol free based temporally cement. All samples were mounted in a computer-controlled materials testing machine with a loaded up to50N ,100N,150N,200N and data were recorded using computer software. Vertical displacement was measurement by using the image analysis software.* ***Results***. *It was found that heat cure acrylic resin group recorded statistically significant highest (p<0.05), μ -movement mean value (75.70±7.615 μm) followed by dual cure composite group (53.15±5.330 μm). While, CAD/CAM resin group recorded statistically significant (p<0.05) lowest μ -movement mean value (39.66±3.325 μm) as indicated by ANOVA test followed by pair –wise Tuke's tests.* ***Conclusion***. *Ceramill Temp (acrylic resin) implant supported bridges showed the lowest vertical micromovement compared to composite resin and heat cure acrylic resin provisional restorations.*

Keywords: *Implant, Provisional Restoration Material, Micro Movement.*

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INTRODUCTION

Temporary restorations play a fundamental role in oral rehabilitation. They can be used over teeth or over implants for a variable amount of time during the period prior to rehabilitation with permanent restorations [1,2]. It should have good marginal integrity and esthetics, and have sufficient durability to withstand the forces of mastication. A fractured provisional is damaging to the prosthetic treatment requiring necessitating prosthodontics care and may result in an unscheduled appointment for repair. For patients with bruxism or those whose treatment plans require long-term use of provisional restorations, such as when periodontally involved teeth are retained during the osseointegration of an implant, provisional restorations with improved physical properties are required [3,4]. The amount of osseointegration is paramount to physiologic success, whereas the degree of mechanical integrity within the prosthodontic interfaces is crucial to prosthodontic success [5]. Materials commonly used to fabricate provisional restorations are polymethyl methacrylate, poly ethyl methacrylate, bis-acryl composite, and epimine. Several investigations have compared the physical properties of these materials and suggested the use of the bis-acryl composites because of their superior properties [6].

Vertical and lateral loads from mastication induce axial forces and bending moments and result in stress gradients in the implant as well as in the bone. A key factor for the success or failure of a dental implant is the manner in which stresses are transferred to the surrounding bone. Load transfer from implants to surrounding bone depends on the type of loading, the bone–implant interface, the length and diameter of the implants, the shape and characteristics of the implant surface, the prosthesis type, and the quantity and quality of the surrounding bone ([7,8].

Micromotion has been described as one of the most important variables affecting the success of immediate loading in dental implants. Micromotion has been defined as "The relative movement of the surface of the implant relative to the surrounding bone [9]. The factors related to the superstructure that would influence implants micromotion could be: cross-sectional superstructure shape [10], low elasticity and the type of material used in design of superstructure [11].

The osseointegration of dental implants mainly depends on the amount of micromovement in the implant system. Thus, the present study is designed to evaluate the impact of the different of provisional restoration and cement as well as the superstructure design on the micromovement on implant prostheses [6].

METHODS

30 acrylic models were constructed to simulate the clinical situation of missing lower three posterior teeth (Second premolar, first molar and second molar) and to receive fixed-fixed bridges on second premolars and second molars, each acrylic block was cuboidal in shape, 40mm in length, 20mmin width and 15mm in height. While Each block contained 2 implants of the same length (11mm), one implant of small diameter (3.9mm) representing the lower second premolar, and other one of larger diameter(4.9mm) representing the lower second molar, 60 implant abutments were prepared using TUT milling machine to make standard knife edge finish line (0.2 mm thickness) with abutment taper of 7 and a height of 6 mm, A specially designed metal frames were fabricated adapted to the acrylic blocks with two holes represented the actual implant places to insure standardization of the distances between implants 15 mm apart [12].

Blocks were drilled by using special designed drilling tools adapted in paralleling device (Bredent, Germany) The drilling tools were fabricated equal to implant sizes (one drill for second premolar and one drill for second molar) to represent the fixture shape of implant.

3 groups were divided according to the type of materials used 10 Samples;

A- Resinous CAD/ CAM (GROUP A)

B- Dual cure composite (Group B)

C- Convention al heat cure resin (GROUP C)

Acrylic bridges were constructed using CAD/CAM technique (Ceramill system) where the steps include scanning (using Ceramill map), designing (using Ceramill mind) and milling (using Ceramill motion). The PMMA bridges were constructed having 0.3 mm thickness at the margins of the crowns and 2mm thickness occlusally, to standardize the bridges dimensions duplication of the CAD / CAM bridges were made using Duplication material (Impression index).

Dual cure composite provisional bridges were fabricated by injecting TempSpan crown and bridge material into the silicone impression (index), from the occlusal surface toward the margin. Keep the mixing tip submerged in the TempSpan crown and bridge material during filling the index to avoid entrapment of air bubbles.

The bridges were cured using Targis Cuick visible light curing unite each unit for 30seconds, buccally and lingually, Once the provisional has completely light cured, the index was removed from the abutment. Allow the provisional bridge to complete its curing away of the prepared abutment for 2 minutes. For an instantaneous complete cure. The provisional bridges were placed in a rubber bowel of hot water for at least 30 seconds to accelerate the set, remove the provisional bridges from the index. Finally finishing the provisional bridge restoration by finishing tools, then clean the provisional restoration with water to remove any loose debris, then dry thoroughly.

For Conventional resin provisional bridges, the Wax pattern was constructed by heating the wax and dropping it inside the index until filled the index from the occlusal surface toward the margin. Seat the index over the prepared abutment side using steady, even pressure. Hold the index firmly in place for 3 minutes to cool. remove the wax pattern from the index. Then refitted and check the margin, then keep the wax pattern in rubber bowel of cold water for 2 minutes. check the wax pattern margin over the abutment.

For the Flasking of wax pattern: The internal surface of the wax pattern was filled by the stone (Plaster of paries type I and left for 20 minutes to set, the wax pattern was put inside the gypsum covered by separating agent, then flask was closed and left for setting about 20 minutes. The flasking was put in boiling water to burnout the wax for five minutes, The acrylic resin powder was mixed with its corresponding liquid in a ratio of 3.5: 1 by volume and wetting for 30 seconds, and wait for 15 minutes to reach dough stage, after that the acryl was put in the flask over the negative space of the wax pattern. After that the flask was put compress and then putt in the normal water until reach temperature of water to 100 degree (boiling water) for twenty minutes.

Cementation of bridge by zinc oxide eugeoul free the provisional bridge was seated on its corresponding implant utilizing static finger pressure then axially loaded with a 2.5kg load [14] using a specially designed acrylic sheet to perform load distribution. The provisional bridge was left under the static load for 5 minutes to ensure cement setting. Excess cement was then removed with a scaler.

All samples (figure 1) were individually mounted in the lower fixed compartment of a computer-controlled materials testing machine [15] with a loaded up to50N ,100N,150N,200N and data were recorded using computer software [15].

Figure 1 Final restoration over the implant abutment

Force was applied with a custom-made load applicator [steel rod with rectangular base (30mm length and 14mm width) placed over the perforated acrylic sheet which placed over the occlusal surface of provisional bridges attached to the upper movable compartment of the machine. Acrylic perforated bar was placed between the loading tip and the occlusal surface of provisional bridges to achieve homogenous stress distribution and minimization of the transmission of local force peaks.

On each model two horizontal lines (Figure 2), were drawn to calculate the distances between them to measure vertical displacement of the bridge after loading

For each specimen five digital images were captured every 50N load from zero to 200N load by the digital camera mounted on the same digital microscope at a magnification 15X with 2048 x 2048-pixel resolution. Images were then transferred to the computer system for analysis. Using the image analysis software (image J), phase analysis was calculated automatically to measure the vertical displacement between the predetermined marks at provisional restoration, and implants. The mean vertical displacement (in microns) for each specimen was then calculated and used for statistical analysis.

An image correlation technique based on photogrammetric principles was used to quantitatively assess the vertical movement of the 2 implants adjacent to the point of load application. Digital image correlation is a noncontact optical method for displacement and strain measurement that has been widely applied in different medical fields [16]. The maximum loads of 200 N were regarded as realistic for anterior and posterior locations, as patients with immediately loaded implants are advised not to use maximum masticatory forces during the first few weeks after surgery [17-18]. For statistical analysis, the vertical displacement of the implants was measured against an immobile reference area on the block specimen. For maximum mathematical accuracy of measurements, the maximum calculable pixel number on the implants was used and averaged to measure the total displacement. The displacement of the superstructure was not calculated.

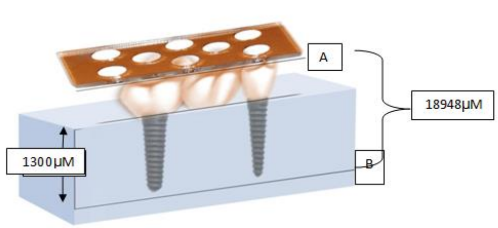

Figure 2. horizontal reference

RESULTS

Data analysis was performed, ANOVA test analysis of variance including load values and FPD provisional material, implant diameter was performed (table 2), pair –wise Tukeys test was performed to detect significance between provisional material

The man values and standard deviation of total implant µ movement with different temporary material and loading values and diameter of implant as summarized in (table 1).

Table 1. µ movement result (mean values + SDs) with different variables

Fixed-fixed bridge			
Variables diameter /force/material		**3.9mm**	**4.9mm**
CAD/CAM	0 N	0±0	0±0
	N 50	22±14	24±1.4
	N 100	38±1	38±1.4
	N150	65±5	73±4
	N 200	83±1	80±1
Dual cure composite	0 N	0±0	0±0
	N 50	34±1	35±1
	N 100	56±2	56±1.5
	N150	66±1.5	65±3
	N 200	95±4	94±4
Heat cure resin	0 N	0±0	0±0
	N 50	70±19	60±10
	N 100	83±29	80±29
	N150	143±20	140±20
	N 200	112±16	107±16

Table 2. Multi factorial analysis of variance ANOVA test

Variation	Df	SS	MS	F	P value
Temporary material	2	25660	12280	75.11	<0.0001*
diameter	1	7.801	7.801	14.33	<0.0018*
Load value	4	198807.1	49701.9	103.03	<0.0001*

**Significant (p<0.05)*

Effect of FPD provisional material

Regardless to other variables, totally it was found that heat cure acrylic resin group recorded statistically significant highest (p<0.05) µ -movement mean value (75.70±7.615 µm) followed by dual cure composite group (53.15±5.330 µm) while CAD/CAM resin group recorded statistically significant (p<0.05) lowest µ -movement mean value (39.66±3.325 µm) as indicated by ANOVA test followed by pair –wise Tuke's tests (table 3).

Table 3. Comparison between total micro movement results (mean values ± SDs) of FPD provisional material

variable	Mean ±SD	(p values)
CAD/CAM RESIN	39.66±3.325	<0.0001*
Dual cure composite	53.15±5.330	
Heat cure resin	75.70±7.615	

*Significant (p<0.05)

DISCUSSION

Ossteo-integrated implants show little mobility; hence, in contrast to the situation on abutment teeth, where a certain degree of misfit of a superstructure may be compensated by the resilience of the periodontium, misfit of FPDs seated on implant may cause a certain stress that is directly transmitted to the surrounding bone [19]. Before performing in vivo studies or applying materials for clinical use, in vitro tests should be undertaken to prove the materials' applicability and performance. In vitro tests can perform in a short period of time and have the advantages of reproducibility and the possibility of standardizing a test parameter [20].

In this study the clinical situation was simulated through several ways. The models used were constructed from acrylic resin which has a modulus of elasticity similar to that of jaw bone [21,22]. The use of the dental surveyor was a must in order to keep the implants parallel to each other. The model material (acrylic resin) was drilling and insertion the implant fixtures, so that the relation of the acrylic resin to the fixture surfaces would simulate osseointegration.

Temporary acrylic and composite resin restorations are commonly used with implant retained restorations as they provide acceptable esthetics and function until the final restorations are ready for delivery, they are also included in the treatment plan when progressive loading way is to be applied [23]. There is presently no ideal provisional material suitable for all clinical conditions. These materials have many requirements, such as appropriate marginal adaptation, nonirritating to gingival tissue, ease of cleaning; contour, alterability, and repair [22]. Furthermore, long-term interim prostheses require materials that are more durable because of their longer periods of service. The chair-side fabrication of temporary restorations is associated with a couple of short-comings, affecting the mechanical strength; such as mixing procedures and filling the over impression might lead to an incorporation of voids. CAD/CAM technologies – used to fabricate temporary restorations – may solve some of these issues;

The samples underwent pre-loading until 200N [15] the maximum loads of 200N were regarded as realistic for posterior location, as patients with immediately loaded are advised not to used maximum masticatory forces during the first weeks after surgery [24].

The results of this study revealed that the type of the provisional materials had significant great effect on the vertical micromovement of the implant inside the study model.

CAD/CAM resin material gave least vertical micromovement compared to dual cure and heat cure resin material which gave the highest vertical micromovement. This may be due to the difference in modulus of elasticity between the tested material, as the more rigid material the more uniform the distribution of force and hence the less micromovement of the implant, this was in agreement with Holst et al and Benzing et al [15,26] who stated that the elastic modulus of material used for superstructure has an important role in stresses distribution and disagreement with Reyes et al [25] how showed high stiffness of material superstructure had greater effect on micromovement.

One of the advantages of carrying out an in-vitro study rather than a clinical study is the possibility of practicing greater standardization and control. In-vitro studies do not show the multiple individual variability of clinical studies.

CONCLUSION

Within the limitation of this study, the result indicate that the type of material used for provisional restoration influenced the micromovement of implant supported prosthesis. Ceramil Temp (PMMA) implant supported bridges showed the lowest vertical micromovement.

Competing interests

Authors have declared that no competing interests exist.

Authors' Contributions

This work was carried out in collaboration between authors.

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