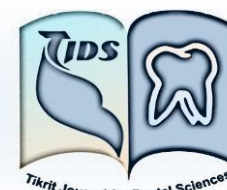




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The Effect of Thermo Cycling on Fracture Resistance Of Temporary Prosthesis Fabricated By CAD/CAM With Composite- Based Material

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Abstract

Aim: The objective of this study was to evaluate the effect of thermo cycling on fracture resistance of temporary prosthesis constricted by computer-aided design/ computer-aided manufacturing (CAD/CAM) with those of composite materials. **Material and Methods:** A dentiform maxillary molar tooth was prepared for full coverage crown, temporary prosthesis was constricted and divided into the following groups: CAD/CAM poly (methyl methacrylate) (PMMA) blocks, and auto-polymerizing temporary material. All specimens were subjected to thermo cycling and then fracture strength was measured by a universal testing machine. **Results:** The mean \pm Standard deviation values for CAD CAM group before thermo cycling (560.50 ± 83.581 Newton) and after thermo cycling (901.00 ± 311.598 Newton) were recorded statistically significant higher fracture resistance mean compared with composite fabricated interim restorations. **Conclusion:** Interim prosthesis constructed using CAD CAM technique showed higher fracture resistance and suitable for long-term clinical performance.

Introduction:

Temporary prostheses are a fixed or removable dental prosthesis must be replaced with a permanent dental prosthesis after a certain amount of time in

order to improve stabilization, aesthetics, and/or function. A successful final restoration depends on a correctly made preliminary restoration (1).

The temporary prosthesis serves to protect the pulp, stop bacterial contamination, stabilize occlusal relationships, and stop the tooth from rotating from its normal position (supra or infra occlusion). It's importance increases greatly for oral rehabilitation cases that needs long term provisionalization from 6 to 12 weeks or even longer (2) . When numerous teeth are involved in a total restoration, the insertion of temporary prosthesis which are regarded as intermediate treatments becomes crucial (3). It's also critical to understand the many criteria for interim restorations, such as the need for marginal precision, adequate structural and wear resistance, and compliance with aesthetic standards while retaining the teeth's polish and luster. (4) . The physical, mechanical, and handling features must be taken into account when choosing a material for temporary restorations in order to make sure that it satisfies the demands of each individual clinical scenario. Because some materials produce potentially dangerous exothermic reactions, it is also crucial to take into account a material's biocompatibility and bio tolerance with soft tissues (5). Temporary restorations can be made using a variety of methods. Polymeric resin, which was first manually applied using direct, indirect, and indirect-direct techniques, is frequently used for temporary restorations. The direct process also uses bis-acryl, which is based on multifunctional methacrylic acid esters and has qualities comparable to those of traditional materials. There are certain limitations to chair-side fabrication of interim restorations, including the possibility that the mixing processes and filling the external mold may introduce voids that could impair the restoration's mechanical strength, surface texture, and accurate fit. (6) .Bis-Acryl and Bis-GMA based materials are superior in their color stability, mechanical properties and have less polymerization shrinkage compared to acrylic resin based materials (7).

The use of CAD/CAM systems in dentistry has increased significantly over the past ten years as a result of developments in the acquisition of intraoral images, the creation of design and production technologies, and the

accessibility of cutting-edge materials for dental restorations. With the use of these tools, restorations may be accomplished in a single appointment, improving the effectiveness and caliber of care. (8) .

The development of computer-aided design/computer-aided manufacture (CAD/CAM) technology has made a variety of materials usable in dentistry. It has become more popular to use these devices to make fixed prostheses as opposed to conventional methods. Additionally, this procedure now incorporates the development of temporary restorations and permits the precise shaping of materials that would be challenging to achieve with a conventional approach to creating a dental replacement (9) .Polymathelmethacrylate PMMA temporary prosthesis made with CAD-CAM avoid the heat of polymerization and shrinkage that comes with auto-cured PMMA. temporary prosthesis made using the CAD-CAM method have more durability, fit, and color stability than traditional restorations. Material waste, the introduction of micro cracks, and limited reproduction of surface features, depending on the size of the milling apparatus, are all downsides of milling fabrication (10)

Although temporary restorations should be built to prevent fractures, they can nonetheless occur. Fractures are a common reason why temporary restorations fail. Particularly when the temporary restoration is to be used for a long time, the patient has Parafunctional habits, or further extension prostheses, like fixed bridges, are planned. Both pain for the patient and financial loss could result from this. As a result, to ensure clinical effectiveness, the mechanical strength of interim restorations is essential and should be considered, especially in long-term scenarios. (11) . Furthermore, the majority of research used thermo cycling or water storage to assess material qualities, which may not accurately reflect the oral situation, which includes both thermo cycling and cyclic occlusal loading (12). Before and after modeling a thermo cycling process, the fracture resistance of four different commercially available provisional crown and bridge materials

and methods, which were exposed to maximum stress, was determined.

Data regarding the fracture resistance of CAD CAM temporary prostheses was maximum force than manual after and before simulated thermo cycling. The aim of this study was to evaluate and compare the fracture strength temporary prostheses of fabrication with CAD CAM technique and these fabricated from bis-acryl composite.

Materials and Procedures

On the master model that made from (chrome cobalt alloy) with a crown Fixed partial denture. the materials tested in this study shown in Table 1 shows. fig. (1.A, B) shown the bilkim CAD CAM acrylic PMMA block and composite (Charm temp, Dent Kist, Inc. Korea) material that used to fabricate the interim restoration.

specimen preparation

A dentiform maxillary molar tooth (Nissin Dental Product Inc., Tokyo, Japan) was used in this study as a model (13). The tooth was prepared according to the standard protocol of all ceramic crown, with occlusal reduction and axial reduction of about 1.5 mm and finishing line of suitable thickness of 1.2 mm, and angle 60 (14) on a chrome cobalt alloy master model with a crown Fixed denture prosthesis that shown in Fig.(2).

20 sample of temporary prostheses materials were hand-mixed construction using the over-impression method. using Polycondensation Silicones (protechno) for laboratory impression material was used. The casted master model was filled with mixed impression material. When the setting period was through, the impression was taken off, and the shape of it was carefully examined for damage. According to the manufacturer's instructions, the auto-mixed temporary composite material was mixed and applied to the over imprint. When setting time is completed according to the manufacturer's instruction, the over impression was swar into two pieces, and the provisional prosthesis material was removed carefully. This method was used for all 20 sample.

the master model was scanned, and a CAD/CAM milling machine received the data set (K5 VHF, Germany), Using a carbide bur, the temporary prosthesis was machined and gently removed from the blocks. Air bubbles were removed from the samples. The incorrect specimens were replaced and thrown away. Fig (3).

Thermo cycling :

10 crowns from each experimental group were subjected to the thermo cycling the cycles used were 1250 cycles which corresponds to 3 months of service inside the oral cavity. Thermal cycles with a temperature extremes of 5°C and 55°C in distilled water (dwell time: 25 seconds, pause time:10 seconds) was performed in the thermo cycling unit. The specimens were placed in a container in thermo cyler (15).

Fracture resistance test:

10 spacemen from each group before thermo cycling and 10 spacemen after thermo cycling are subjected to the compressive load. For fracture testing, the prepared tooth (chrome cobalt alloy) of model was applied in a universal testing machine. A model supported the sample. Using a metal ball with a diameter of 5 mm, samples were compressed at a 90-degree angle to their centers until fracture occurred using a crosshead speed of 1 mm/min. fracture patterns are assessed optically. as evidenced in fig (4).

Results

Descriptive statistics in SPSS of fracture strength which include the minimum, maximum, mean and standard deviation for CAD CAM and composite groups. Table (2) shown the statistical analysis of the highest mean value of fracture resistance of CAD CAM groups (901.00 Newton) after thermo cycling, while the lowest mean value 560.50 Newton before thermo cycling. The highest mean value of fracture resistance of composite 419.50 Newton after thermo cycling, while the lowest mean value 263.00 Newton before thermo cycling. Bar chart showing means of the fracture strength before and after thermo cycling shown in fig. (5).

Comparison between two groups CAD CAM and composite paired t-test for the fracture strength demonstrated that there was a statistically significant difference P-value $P=0.004$ (High Significant) for CAD CAM group and $P=0.000$ (High Significant) for composite shown in Table (3).

Discussion

This study assessed the fracture strength of temporary prosthesis created using various materials and fabrication techniques following simulated thermal cycling. Temporary prostheses, particularly in whole dental implant therapy or mouth rehabilitation should be able to sustain dynamic oral conditions and occlusion stresses for a sufficient period of time. To support its purpose, the right materials must have the necessary strength and stability (16). The modulus of elasticity of the materials chosen for this study is similar to that of enamel. As a result, they provide some stress relief and cushioning to the Periodontal ligament and supporting tissues of the restored tooth as well as the opposing dentition. Furthermore, all of those materials have the benefit of being intra orally repairable. Because they are custom-made, they are more suited to the prepared tooth than prefabricated alternatives. They address the issue of missing and unfitting sizes in prefabricated kits, which frequently result in over reduction and increased chair side time. Under ideal manufacturing conditions, CAD/CAM PMMA blocks are industrially polymerized. Interim restorations made under such conditions have greater mechanical qualities than those made by hand. Their high mechanical qualities make them a good choice for long-term temporary restorations that require a lot of strength. Furthermore, the superior fit of milled CAD/CAM products should reduce the danger of bacterial contamination of the tooth and protect the pulp from damage caused by extreme temperature changes(12). Concerning the results of fracture resistance, the lower fracture resistance values of manually fabricated crowns observed in this study can be

justified based on the method of polymerization and the higher residual monomer ratio compared to CAD/CAM crowns(17). The observed fracture resistance results are consistent with results reported by Yao, et al, in 2014 who found that CAD/CAM provisional materials displayed superior strength than bis-acryl provisional materials, especially after thermal cycling. (18). But current obtained results were almost double that reported by Wanner (31) who compared the mechanical properties of 3 different types PMMA blocks. This may be due to different PMMA CAD CAM blocks used. On the other hand, Abdullah, et al in 2016 reported that not all CAD/CAM provisional crowns displayed superior fracture strength to that of the direct provisional material, which may be resulted from different methodology adopted.(9) The temporary material employed in this work for CAD/CAM milling is a highly polymerized PMMA polymer based on strongly cross-linked resins. It is created by an industrial method in a carefully monitored setting that can reduce flaws and contaminants while maintaining pressure throughout the polymerization process. When employing traditional hand-mixed composite methods, this can be impossible. As a result, when compared to the traditional direct PMMA, the CAD/CAM PMMA blocks showed superior attributes, corroborating the study's findings. According to reports, the interim composite prosthesis has a propensity to absorption of water, which causes the destruction chains of polymeric by hydrolysis of the monomer, which lowers the composite's mechanical qualities(19)PMMA polymers used in industrial CAD/CAM systems have a more homogenous structure, less free monomers, and this could account for why CAD/CAM PMMA polymers have better mechanical characteristics than traditional PMMA resins. These findings were in line with a study by Alt et al. that found hand mixing (traditional) techniques produced worse results to CAD/CAM fabrication of the identical materials. The main reasons for this subpar result could include unpredictable mixing procedures and

defects, which are typically found in conventional methods. They also came to the conclusion that thermo cycling interim prostheses had a substantial impact on the fracture toughness of milling PMMA, albeit to a smaller extent than directly produced (20).

Conclusion

Within the limitations of the present in this study, CAD/CAM temporary prostheses

showed good mechanical properties compared to conventionally fabricated prostheses. CAD/CAM fabrication is suitable for long-term clinical temporary prostheses.

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Fig. (1) (A)- dispensing gun used for mixing and dispensing of Charm temp
(B)- CAD CAM flexible acetal PMMA



Fig.(2) The Cr-Co-alloy-prepared tooth mode

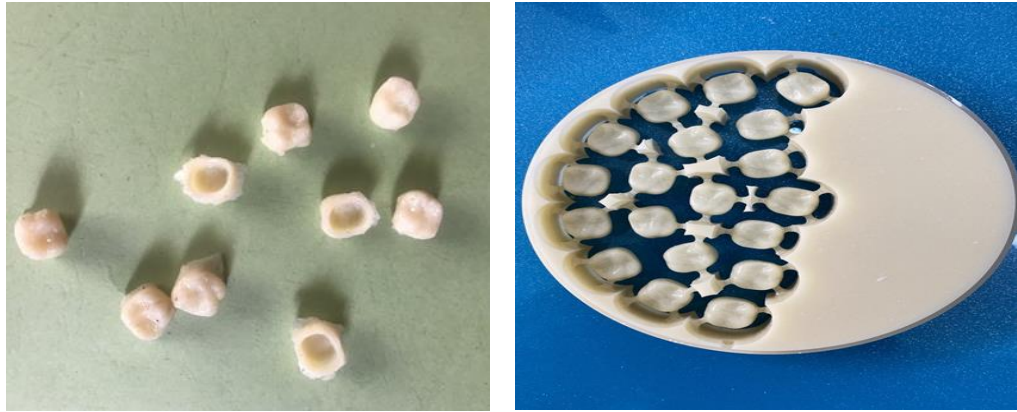


Fig. (3) A. composite interim samples
B. CAD CAM interim samples

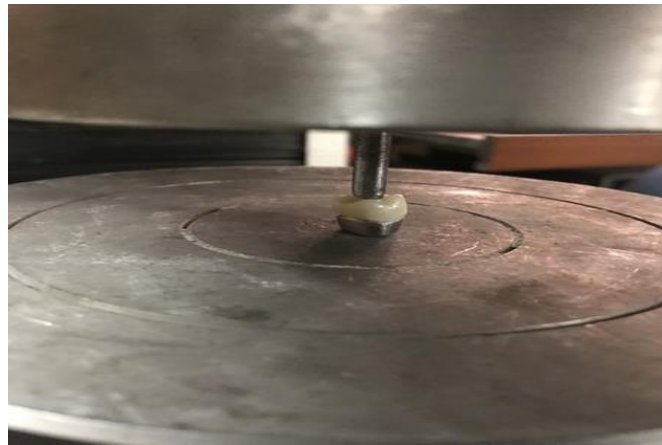


Fig. (4) Universal testing machine for fracture testing

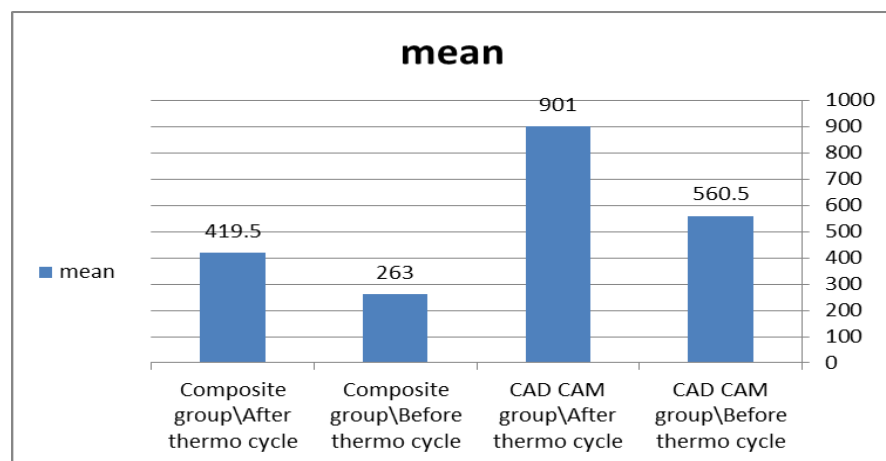


Fig. (5) Bar chart represent mean value SBSS of studied groups

Table (1): The study's products

Product name	manufacture	Base material	Number of sample
Bilkim co.LTD	Ismir, turkey	flexible PMMA acetal (CAD CAM)	20
Charm Temp	Dent Kist, Inc. Korea	Bis-acryl	20

Table (2): Descriptive Statistics of thermo cycle of Studied groups

	Newton	Minimum	Maximum	Mean	Stander Deviation
CAD CAM group\Before thermo cycle	10	440	670	560.50	83.581
CAD CAM group\After thermo cycle	10	600	1525	901.00	311.598
Composite group\Before thermo cycle	10	205	415	263.00	73.907
Composite group\After thermo cycle	10	325	570	419.50	75.515

Table (3): Comparison between Before thermocycle and After thermocycle according to Studied groups

	Studied groups	P-Value
CAD CAM group	Before thermocycle	P=.004 (High significant)
	After thermocycle	
Composite group	Before thermocycle	P=.000 (High significant)
	After thermocycle	

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