AJDS LAZHAR *Al-Azhar Journal of Dental Science*
*Vol. 21- No. 3- 293:297- July 2018*
*Record 1110-2624 | the ISSN Portal*
*portal.issn.org*

# FRACTURE RESISTANCE OF THIN OCCLUSAL VENEERS MADE FROM HYBRID CERAMIC (CERASMART) -IN VITRO STUDY

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## *ABSTRACT*

**Statement of the problem:** Occlusal veneers represent a conservative alternative to traditional restoration for restoring tooth wear. However, the ability of occlusal veneers with thin (reduced) thickness using hybrid ceramics to withstand masticatory forces in the posterior area is not yet known. **Purpose:** the purpose of this in vitro study was to evaluate the fracture resistance of thin occlusal veneers made from hybrid ceramic (Cerasmart). **Materials and methods:** Twelve human first maxillary molars were used in this study collected from patients with untreatable periodontal problems (grade III mobility); Teeth were chosen to be free from any caries, defects or Cracks. (n= 12) Teeth were prepared to receive Cerasmart occlusal Veneers with 1.8 mm thickness at the cusp tip and 1.2 mm at the central groove. A standardized tooth preparation was applied to all specimens using CNC milling machine, with anatomical occlusal surface preparation with 1 mm ferrule and 1mm deep chamfer finish line. Then occlusal veneers were fabricated by CAD/CAM milling using The CEREC AC system. Then all occlusal veneers were checked over their corresponding teeth for Seating. Then cementation using Re1yX™ Unicem (dual cure self-adhesive resin cement). All samples were subjected to thermo-cycling for 1000 cycle, and cyclic loading for 25,000 cycles. The samples testing was done by compressive mode using a universal test machine along the long axis of the occlusal veneers using load applicator in the form of metallic rod with rounded end (5 mm diameter). Data were collected, tabulated and statistically analyzed. **RESULTS:** The mean values and standard deviation of fracture resistance (N) measured by fracture resistance test as a function of restoration thickness. It was found that occlusal veneers with a thickness of 1.2 and 1.8 mm recorded fracture resistance mean value (1743.7± 387N). **CONCLUSIONS:** Within the limitations of present in vitro study, Hybrid ceramic thin occlusal veneers with a thickness of (1.2 and 1.8 mm) can withstand the masticatory forces in the posterior area, which providing a conservative treatment for tooth wear.

**KEY WORDS**: Attrition, occlusal veneers, hybrid ceramic, fracture resistance.

## INTRODUCTION

Excessive loss of coronal tooth structure or severe tooth wear is not uncommon in the general population[1]. The tooth wear has a multifactorial etiology and can be associated with dietary habits, medical conditions, and/or oral habits that lead to attrition, abrasion, and erosion of the enamel and dentin [2,3].

The destruction of tooth structure has been a significant concern as it affects musculoskeletal harmony, occlusal stability, oral comfort, esthetics, and overall the patient's satisfaction with their dentition [4,5,].

The hybrid ceramic CAD/CAM materials have been proposed to produce materials with a closely matched modulus of elasticity to dentin, a more easily milled material than glass ceramics or polycrystalline ceramics, a material that is easily repaired intra orally & has superior esthetic properties [7]. Recently, a hybrid ceramic CAD-CAM material was introduced, called Cerasmart which consists of a polymer (29 wt. %). with an even distribution of nano ceramic (71 wt. %), This specially designed hybrid ceramic makes it an ideal high strength and force absorbing restoration for all indications (Inlays, onlays, crowns, veneers, and implant supported crowns) [8,9].

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Occlusal veneers are extra coronal restorations requiring a simpler and relatively non-invasive preparation driven by interocclusal clearance and anatomical considerations [10,11]. the usual recommendation for ceramics restoration thickness is 1.5 to 2.0 mm. However, the development of stronger materials in combination with CAD/CAM techniques and innovative adhesive technology such as immediate dentin sealing, more conservative approaches should be considered. Yet, there is a significant lack of data regarding the selection of the appropriate material and the suitable thickness and its influence on the fracture resistance of such thin, mechanically nonretentive occlusal veneers [12,13].

The null hypothesis There was no significant results with respect to fracture resistance of the posterior thin occlusal veneers constructed from hybrid ceramic (Cerasmart).

## MATERIALS AND METHODS

### Collection of natural teeth:

Twelve human first maxillary molars were used in this study. Extracted maxillary first molars from patients with untreatable periodontal problems (grade III mobility) especially from uncontrolled diabetic patients were collected through two months before tests applications. The teeth were inspected under high light condition with magnifying lens (2 X magnifications) to ensure they were free from any caries, defects and Cracks**.** Teeth of nearly similar size and shape were selected by root length and crown dimensions. Measuring was done using a digital caliper. The average tooth dimension was (21 ± 1 mm) in length, (11 ± 1 mm) in labio –palatal width, and (9.5 ± 0.5 mm) in mesio-distal width. A specially designed centralizing metal device was constructed to allow an accurate centralization of the teeth in the epoxy resin blocks.

### Teeth preparation to receive occlusal veneers restoration

A standardized tooth preparation was carried out to all specimens using CNC Milling Machine (M400 CNC Milling Machine -CENTROID 159 Gates Road Howard, PA 16841, USA.). After scanning of teeth, the CNC milling machine was programed to do preparation with a round-ended, tapered diamond rotary cutting instrument, with the following dimensions; the buccal and palatal margins of prepared occlusal surface were maintained initially at approximately 5.5 mm from the CEJ and 2.±4 mm above the central groove keeping the cuspal inclination as constant as possible. Then Preparation of circumferential deep chamfer finish line 1mm thickness, with 1 mm ferrule and with 6 degree axial walls tapering. Each mounted, prepared tooth was inspected for disqualifying characteristics such as cracks or fractures using magnifying lens Figure (1).

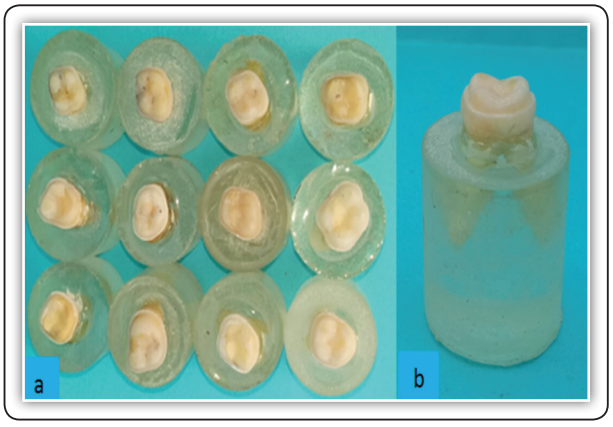


Fig. (1): Teeth preparation for occlusal veneer with 1 mm ferrule and 1mm deep chamfer finish line occlusal view a, and buccal view b.

### Laboratory procedures

Occlusal veneers were fabricated by CAD/CAM milling using The CEREC AC system. Also with the purpose of standardization, spacer was set at 30$\mu$m for all samples. Then all occlusal veneers were checked over their corresponding teeth for Seating.

### Cementation procedures:

The internal surface of the restorations was rinsed with water and air dried, then sandblasted with 50 $\mu$m aluminum oxide particles (according to the manufacturer) using sandblasting machine, Fitting surface of veneers were cleaned with alcohol

and dried with oil-free moisture-free air. The internal surface of all restorations was then salinized using silane coupling agent for 60 s then air dried for 5 sec. The prepared teeth were washed with water and dried with air only, taking care not to over dry the teeth surfaces. Then Re1yX™ Unicem capsules (dual cure self-adhesive resin cement) were activated by using special device. Then mixing of Re1yX™ Unicem capsules for 10seconds using an amalgamator. According to the manufacturer's instructions and was applied to the intaglio surface of the occlusal veneers using capsule applier. This was then placed in position with gentle finger pressure on the corresponding tooth and placed in the cementing device. Rely x Unicem resin cement was polymerized for 3 seconds, and then excess luting material was removed using a sharp excavator, After that each surface was further polymerized for 15 second, using SmartLite Max LED curing light. All samples were subjected to thermo-cycling for 1000 cycle, and cyclic loading for 25,000 cycles.

**Fracture test**

All samples were individually mounted on a computer controlled materials testing machine (Model 3345; Instron Industrial Products, Norwood, MA, USA).with a load cell of 5 KN and data were recorded using computer software (Instron® Bluehill Lite Software). Samples were secured to the lower fixed compartment of testing machine by tightening screws. Fracture test was done by compressive mode of load applied occlusally using a metallic rod with round tip (5 mm diameter) attached to the upper movable compartment of testing machine traveling at cross-head speed of 1mm/min. With tin foil sheet in-between to achieve homogenous stress distribution and minimization of the transmission of local force Peaks. (Figure 2 a, b),The load at failure manifested by an audible crack and confirmed by a sharp drop at load-deflection curve was recorded using computer software (Bluehill Lite Software Instron® Instruments). The load required to fracture was recorded in Newton.

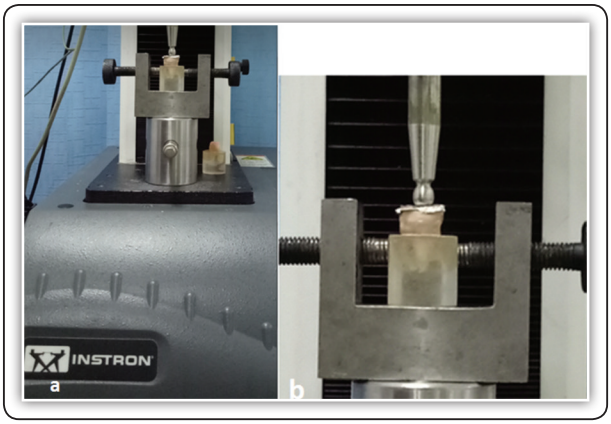


Fig. (2): Universal testing machine a, tin foil was placed between the tooth and loading tip b.

## RESULTS

The mean values and standard deviation of fracture resistance (N) measured by fracture resistance test as a function of restoration thickness are summarized in Table (1).It was found that thin occlusal veneers with thickness of 1.2 and 1.8 mm, recorded fracture resistance mean value of (1743.7 N).

**TABLE (1):** Descriptive statistics of fracture resistance results measured as a function of restoration thickness.

| | ***Thickness of* 1.2 *and* 1.8 *mm*** | | |
|---|---|---|---|
| | Mean | SD | 95%CI |
| Fracture resistance (N) | 1743.7 | 387 | 1497.33 to 1990.16 |

## DISCUSSION

Preservation of tooth structure is a major driving force in restorative dentistry.[10] from a biomimetic perspective, the conservation of tooth structure is paramount in maintaining the subtle equilibrium between biologic, mechanical, functional, and esthetic parameters. It is clearly beneficial to keep the pulp alive and prevent endodontic treatment and the need for posts and cores, because these more invasive approaches violate the biomechanical balance and compromise the performance of restored teeth over

time [14]. Teeth were prepared according to clinically established preparation criteria for ceramic occlusal veneers [15] all samples were constructed using CAD/CAM technology which gives us the ability to control thickness and anatomy of restorations during the fabrication process. It also allowed the standardization of the internal fit of the restoration as well as the dimensions and the mechanical properties of the restorative materials. Newly developed conservative restoration, such as occlusal veneers has been based on the concept of microretention (rather than macro-retention), which allows better conservation of the dental structure, provided that appropriate adhesive procedures are used. Using a CNC machine to ensure standardization of the preparations. Fracture resistance was chosen in this study as it is the critical factor that determines the success and longevity of a restoration. In vitro tests were used because they overcome the many limitations associated with clinical test such as individual variation by creating a controlled environment. This test provided a guide line about the load bearing capacity of the thin thickness and act as base for clinical studies. Based on the results of this study the null hypothesis regarding restoration dimension was rejected, since there was significant results with respect to fracture resistance of the posterior thin occlusal veneers constructed from hybrid ceramic (Cerasmart).

Results of the present study showed that the mean fracture loads of tested samples (1743.7± 387N) were beyond the mean reported maximum masticatory force. Therefore, it could be assumed that all the tested specimens could withstand the maximum intraoral posterior masticatory forces. That was in agreement with Dds et al. [16] and Egbert et al. [17], who reported that maximal loads at fracture for occlusal veneer restorations fabricated from hybrid ceramic blocks at minimal occlusal thicknesses of 0.3, 0.6, and 1.0 mm, were found to be higher than the reported range of human masticatory forces.

These results were approved by Chen et al. [18], who reported that there was a linear relation between restoration thickness and fracture resistance for IPS E.max CAD, but not for Lava Ultimate CAD/CAM (hybrid ceramic); Indicating that veneer thickness doesn't affect its fracture strength.

## CONCLUSIONS

Within the limitations of present in vitro study the following conclusion could be withdrawn:

-Hybrid occlusal ceramic veneers (Cerasmart) with thin thickness can withstand the masticatory forces in the posterior area, which providing a conservative treatment for tooth wear.

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