Bond Strength and Microleakage of Different Designs of Occlusal Veeners

Mohamed G. Hussein[1*], Cherif A. Mohsen[2]

Abstract

The purpose of this study was to investigate fracture strength of different lithium disilicate occlusal veneers designs with different tooth preparations. **Material and method:** Fifty-six extracted human mandibular molars were collected with relatively comparable size and standardization done by diamond saw and it will receive. 6mm lithium disilicate occlusal veneers. Specimens will be divided into two main groups, each of these groups contains 28 samples (group A&B), the first group represents occlusal veneers with 1.0 ml with radial shoulder finish line design includes axial surfaces for a2 ml length, while the second group represents occlusal veneers preparation without finish line. Each main group will be subdivided into 2 subtypes groups (A1, A2, B1, B2), each subtype group contains 14 samples, the first subtype group will receive a buccal groove, while the second subgroup will be without grooves. Each subgroup will be divided into 2 classes (7 samples) according to the type of test it will be subjected to: microleakage, bond strength. **Results:** The fracture strength is (mean value+ standard deviation) in plain occlusal reduction without vs with buccal groove(890.36±42.51N), (865.69±36.79N). The fracture strength is (mean value ± standard deviation) in occlusal reduction with radial shoulder, without or with buccal groove (835.36±42.51N), (820.69±36.79N), with non-significant difference p value >0.05. **Conclusions:** All tested occlusal veneer designs proved to withstand normal and parafunctional masticatory forces with non-significant statistical difference.

Key Words: Occlusal Veneers, Lithium Disilicate, Additive Manufacturing.

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Introduction

As a result of the work of many scientists, normal users of science indicate that ultrathin crown and bridge-like veneers are a better solution than traditional only and complete crowns to deal with severe and erosive conditions because of tooth destruction [1]. The development of new materials such as lithium disilicate and new strong composite resins and additive manufacturing (AM) techniques has also been useful so that they can use them on devices aimed at providing improved strength and decreased weight (such as immediate dentin sealing [IDS]). Dietschi et al. have shown that a new and improved class of restorative design is now available. [2-4].

On the other hand, thin hybrid ceramic veneers have been shown to be highly resistant to fatigue from use. While the bond strength is obtained from the load that contains the maximum pressure that gets pressed later divided by the cross section of the bonded interface and also referred to as the average bond strength value [5].

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Material and Method

Fifty-six extracted human mandibular molars were collected from outpatient hospital of Faculty of Dentistry-Minia University and Assuit governmental hospital. Teeth were selected in such a way that the mean buco-palatal width of the teeth varied by no more than 2.5 per cent [6]. Standardized tooth preparations replicating a worn occlusal table were accomplished using a diamond saw (Fig 1). Using a digital caliber to measure 4mm [6] occlusal to CEJ the remaining entire coronal structure was removed sectionally perpendicular to the tooth's long axis. Indexing notches on the rotary bur were created on the mesial and distal finish lines using a high-speed rotating diamond bur.

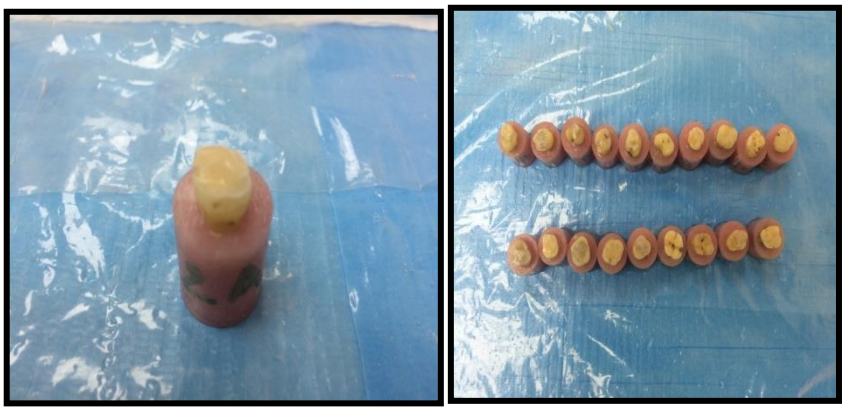

Figure 1. Extracted tooth specimen mounted in acrylic base.

The design used in this study was Factorial where the teeth were then randomly assigned to two groups based on the two basic preparation designs to be tested:

- plain occlusal reduction
- occlusal reduction with axial radial shoulder (1ml).

Each group was separated into 2 subgroups (n=14) according to the type of preparation either with buccal groove or without buccal groove preparation. However, within each subgroup, specimens were subdivided into 2 classes (n=7) based on test that it will subjected to it either fracture resistance or microleakage test.

Scanning of the prepared samples: A standardized hanger was created by trimming the cervical structure of a denture tooth that was an anatomic readymade denture to within.6mm of the central fossa of the tooth measured by the caliber (fig 2).

Figure 2. Measuring gcentralfossa by caliber.

It was mounted on the dental models during the occlusion scans using the Inlab MCX5 milling machine (Fig 3).

Figure 3. Images of specimens prepared and without occlusal.

Custom restoration fabrication: Using the virtual design tools within the software, the occlusal cervical dimensions were adjusted to the prescribed thicknesses assigned to each test group. Optimal standardization of e-max lithium disilicate of 0.6 mm. (measured from insertion point depth to top of incision).

Finishing and Polishing

Lithium disilicate veneers were finished and polished using sof-lex^{tm} discs and diamond polishing paste with silicone impregnated rubber cup

Cementation

The internal surfaces of all restorations were subsequently activated by silane coupling agent for 60 seconds before air-drying for 5 seconds.

- The prepared teeth were washed with water and dried with air taking care not to overly dry the tooth surface, - Carefully pre washed pre-prepared tooth surfaces with 37.5% phosphoric acid for 15 seconds, rinsed thoroughly and blot dried without desiccating dentin. Will be reinforced with self-adhesive, dual-cure, resin cement.

Fracture Strength Testing

First, the mechanical aging process was performed on the samples by using a PC controlled equipment; later the samples were embedded in Teflon housings in the lower sample holder. A weight of 5 kg, which is comparable to 49 N of chewing force, was exerted by a universal testing machine's compressive mode (model 3345; instron industrial products, norwood, ma, USA). The tests were conducted with the use of computer software and confirmed by a distinct crack and a sharp drop at the load-deflection curve.

Statistical Analysis

One-way ANOVA followed by Scheffes post hoc test was used to statistically analyze the difference in failure load among the different designs of preparation. After fracture, the samples were examined using a stereomicroscope, camera, or other electronic imaging device.

Results

The mode of failure: it was categorized as the following

Mode 1: restoration only factor, mode II: restoration and enamel fracture, or mode III: restoration fracture, enamel and dentin. A spearman, s grade-order correlation was used to test the correlation between the load of the fracture and the failure mode of each of the designs.

In occlusal veneers made with axial expansion, plain occlusal veneers either with oral grooves or without oral grooves, statistic differences in fracture forces were found (Fig.4) shows three types of failure. The samples number for each failure were non-sequential different (One way: ANOVA($p<005$) (1).

In the 56 specimens41 were fractured in a veneer material (mode II) and one of these 56 had a complete fractured restauration delamination. Ten specimens were fractured in restauration and nomel (modeII) fractures and five specimens were broken in restoration, enamel and dentin(modeIII).

Table 1.

Variables		Ceramic group Lithium disilicate	
		Without buccal groove (0.6)mm	**With buccal groove (0.6) mm**
Preparation design	**Plain occlusal reduction**	(890.36±42.51N)	(865.69±36.79N)
	Occlusal reduction with radial shoulder	(835.36±42.51N)	(820.69±36.79N)
t-test	**P value**	>0.05	>0.05

Means were compared by one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test for multiple comparisons. Multiple t-tests were done between two subgroups. Statistical analysis was performed using GraphPad Prism software for windows.

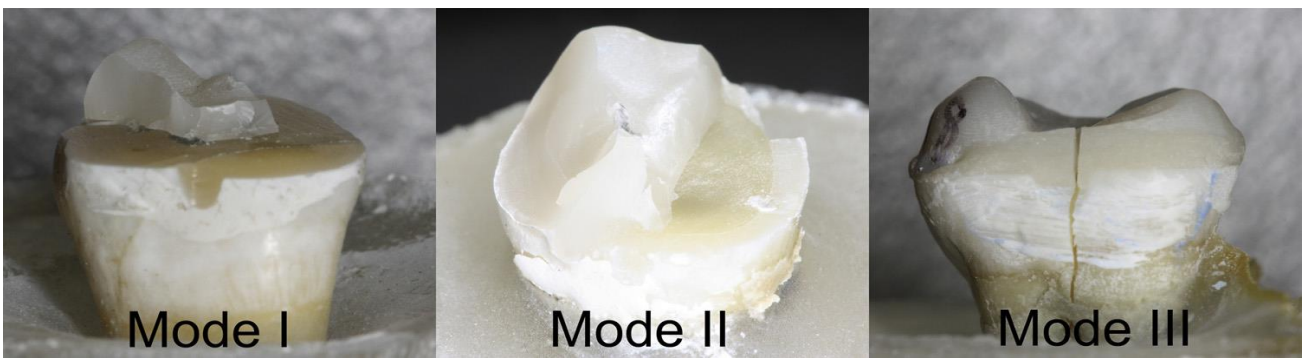

Figure 4. Failure modes: Mode I, failure of restoration; Mode II, failure of restoration and enamel; and Mode III, failure of restoration, enamel, and dentin.

Discussion

Dental preservation is a driver in restaurant dentistry [7-8]. From a biomimetic perspective, the stability of tooth structure in changing times is notable (9). Thus, it is clearly much better to keep the pulp alive and prevent root canal treatment. Newly developed conservative restoration, such as occlusal veneers has been based on the concept of micro-retention (rather than macro-retention), which allows better conservative of the dental structure provided that appropriate adhesive procedures are used [10,11]. By applying translative principles in post-occlusal veneers (thin onlay/overlay with non-retentive design) the benefits of decreasing retentive functionality in dentures can be enhanced. Such restorations may be competitive with onlays/overlays of gold. Extra coronal restorations are occlusal veneers, which involve easy and intuitive planning, guided by anatomical considerations and an interocclusal clearance [12]. Molars of similar crown size and root size have been used to eliminate potential differences and errors, allowing the same size of crowns built with CAD/CAM technology and the same elasticity clinical model. Various factors affect the resistance to fracture from all-ceramic restorations, such as ceramic material microstructure and fatigue, the manufacturing process, nature of final preparations and the luting system [13].

For samples standardization, a biogeneric-copy mode in the Cerec software version 4.3.1 was used, so that each artificial crown is designed and milled as an exact replica of the unprepared anatomy. An effort was made to standardize preparations with the use of depth cutters diamond stone and putty index before preparation. Due to its ability to monitor thickness and restoration anatomy during the manufacturing process, CAD/CA M technology was selected. The internal fitting of the restore and the mechanical properties of the restorative materials were also normalized [14].

The structure, physical and mechanical properties of the CAD/CAM materials available differ widely and, consequently, their mechanical behavior will also vary in the tooth restoration complex [15]. Lithium disilicate CAD/CAM blocks was chosen because it has the advantages of long-term clinical acceptability, good bonding characteristics, favorable esthetics and lack for veneering porcelain need.

The occlusal veneers were cemented using dual cure adhesive resin cement which had the advantages of controlled working time and adequate polymerization in areas that are inaccessible to light. Universal testing machine was used to apply load of 6 N parallel to the long axis of each occlusal veneer to prevent re-bonding during cementation[16]. Fracture resistance were chosen in this study as they are among the critical factors that determine the success and longevity of a restoration. The dynamic fatigue was tested in a universal testing machine to replicate conditions which are closest to the clinical situation. Ceramics are brittle materials, considering their many advantages. Subcritical spread of crack will lead to disastrous failure. Before its clinical application, it is important to in vitro test for a ceramic fracture resistance.

As far as fracture resistance is concerned, depending on facial morphology and age the physiological maximum occlusal forces can vary to 500 Newton. [17] Results of several studies have shown mean load force to be between 50 and 250 n, while parafunctional behaviors like tightening and brux is lead to loads from 500 to 800 n. The molar region's average effective chewing force is 847 N. Men's and 597 N. For women. - For women [18].

Within the limitation of this study, the following conclusions were found

- Occlusal veneers were found to be a successful mean of restoring erosive posterior teeth.
- ll tested occlusal veneers designs proved to withstand normal and parafunctional masticatory forces.

Source of Funding

Self funding.

Esthetical Clearance

Study was done in vitro study samples.

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