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Influence of Restoration Thickness and Auxillary Retentive Means on Fracture Resistance of Occlusal Ceramic Veneers

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Abstract

Objectives: To evaluate the influence of restoration thickness and auxillary retentive means on fracture resistance of occlusal ceramic veneers.
Materials and Methods: Forty sound molars were chosen which are free from caries, The teeth were divided into two classes and restored with CAD/CAM lithium disilicate ceramic occlusal veneers. Group (1) has no finish line, while Group (2) has a finish line. Each category consisted of 10 molars with buccal groove extension and 10 molars without it, with two thicknesses of 1 and 1.5 mm.Usage of a universal testing machine to measuring the fracture strength of lithium di silicate material after loading till fracture.
Results: Only specimens in the group with the thickest thickness of (1.5 mm) survived cyclic loading without any damage. Survival rates in the remaining sub-groups ranged from 50 to 100% for surviving with some damage and from 12.5 to 75% for surviving without any damage. Medians of final fracture resistance ranged from 772 to 902 N. In groups with larger ceramic thickness (1.5 mm) provided statistically significant ($p \leq 0.05$) higher fracture resistance than smaller one.
Significance: Usage of 1.5mm thickness buccally retentive lithium disilicate ceramic occlusal veneers can restore successfully severely abraded teeth.

Introduction

Today severe tooth wear is popular in the general population [1] .Teeth wear is a very serious condition affect the oral cavity which can make spontaneous and continuous pain with the function of the oral cavity as it decreases the vertical dimension of occlusion ,occlusal stability ,dentin exposure and make tmj problems.The causes of teeth wear are dietary habits, medical conditions, and/or oral habits that lead to attrition, abrasion, and erosion of the enamel and dentin [1,2].Musculoskeletal harmony and occlusal stability are affected with the destruction of tooth structure besides oral comfort, esthetics, and the patients' satisfaction with their dentition. [3,4].

Restorative treatment of such cases may involve multiple full-coverage crowns, surgical lengthening, and endodontic treatment [5].But this require increase the amount of removal of tooth structure and the healthy tissues. Patients can be treated by such ways for many reasons such as cost or some technical problems. Usage of recently adhesive restorations has the ability to decrease tooth structure removal.[6]

The durability of the restoration is an important factor when choosing it to give better performance under occlusal load and resist the fracture . Lithium di silicate material (LDM) has the desired esthetics and durability. CAD/CAM technology and materials gives more chances for restoration of severely abraded dentition when space is limited [7] .

Thin occlusal veneers constructed from composite resin blocks have been shown to outlast reinforced ceramics in terms of fatigue resistance. Ultra thin occlusal veneers have a minimum thickness of 0.3&0.6 mm exhibit a variety of clinical behaviors [8].

Lithium di silicate occlusal veneers of 1 mm thickness have the ability to provide good output under static load with limited tooth reduction and minimal preparation to reach to acceptable inter occlusal clearance[9].The usage of the resin composite cement has the advantage of increase the strength of the LDS material and its retention to tooth structure [10] .

Materials and Methods

Forty sound molars were chosen which are free from caries, filling or any defect.The teeth were restored with ceramic occlusal venners of CAD /CAM lithium disilicate material ceramics. Samples were divided into 2 groups according to the absence or presence of a finish line (20 samples each) . Then each group was subdivided into 2 subgroups 10 samples each according to the thickness of the restorations and in each subgroup there were 2 classes (5 samples each) if they had a buccal groove or not,as shown in figures (1,2).The teeth were fixed in acrylic block and its roots were coated with gum resin (Germany) to act as an artificial periodontal membrane. The resin was 2 mm below the CEJ.The teeth will receive different occlusal veneer preparation according to the sample design.

Construction of occlusal veneers made by the CAD/CAM machine,Restorations were made resempeled the occlusal anatomy of natural teeth which had multiple fossae and grooves with no sharp angles and gave the natural rounded appearance of tooth structure . lithium disilicate material (IPS e.max.CAD,

IvoclarVivadent) was the type of the restoration used. The milling process done inside the e_max cad block according to the sample construction.

Figure 1: *preparation with shoulder finish line*

A self-etching primer (3M ESPE) was positioned on the tooth surface after etching by 35% orthophosforic acid gel, as shown in figure(2).

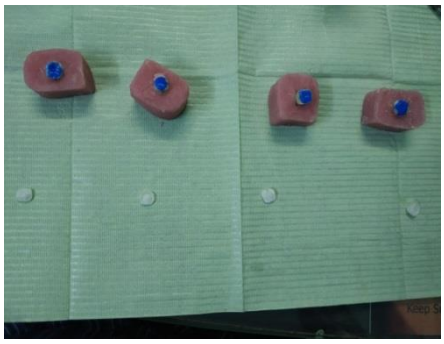

Figure 2: *Acid etching of the tooth surface*

5% hydrofluoric acid etching gel (BISCO,USA)was used for 20 seconds for the etching process of ceramic veneers .Water spray was used for cleaning the surfaces after the etching process. A silane coupling agent (BISCO,USA)was applied and then air dried after 60 sec.Bonding of the restorations was the most important procedure made by using a dual-curing composite resin cement (3M ESPE) which applied on the fitting surface of the veneers .All margins were light-cured (figure 3)

Figure 3: *Light curing of resin cement*

to be sure of the bonding process.The margins were polished and any sharp edges were removed.

The specimens were loaded till fracture (figure 4)by a Universal Testing Machine (Zwick Z010/TN2A, Ulm, Germany). The main fossa of each specimen was exposed to a steel bar with a 6 mm ball end to apply the load consistently to the cusps. Used a 0.6 mm tin foil between the ball end and the specimen to allocate the load consistently. The computer software recorded the maximum load till fracture while the steel bar descended with speed of 2 mm/min.The data was collected and statically analyzed.

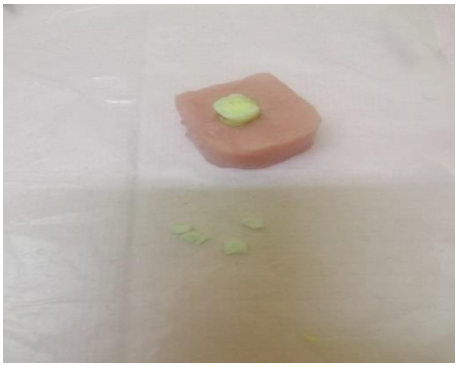

Figure 4 : Fracture of occlusal ceramic veneer

RESULTS

Fracture resistance (N) (Mean±SD) for the two groups under function after mechanical cyclic loading are shown in table (1) figure (5). Experimental subgroups of group(2) recorded statistically significant higher fracture resistance mean value (902.55) than conventional subgroups of group (1) mean value (771.69) as indicated by t-test (P=0.007 <0.005).The buccal groove extention had more fracture resistance than design without it.

Table (1):Fracture resistance (N) (Mean±SD) for lithium di silicate groups under function after mechanical cyclic loading.

Group (1) conventional 20 without F.L				**Group(2) 20 with shoulder F.L**			
1 mm		1.5 mm		1 mm		1.5 mm	
without B.G	with B.G	without B.G	with B.G	without B.G	with B.G	without B.G	with B.G
A	B	C	D	A	B	C	D
771.69	**775.69**	**774.57**	**778.57**	**891.36**	**894.36**	**899.55**	**902.55**

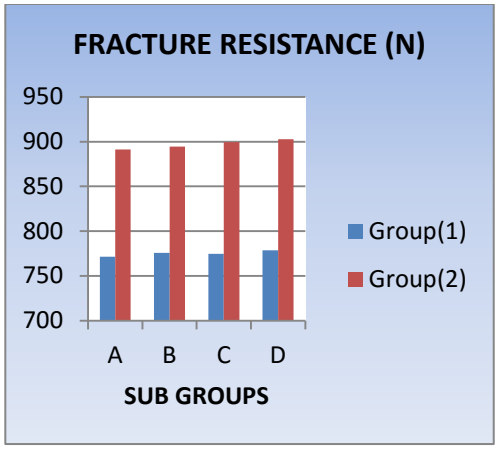

Figure 5 :*Fracture resistance (Mean±SD) for lithium di silicate groups under function comparing preparation designs after mechanical cyclic loading.*

Discussion

Occlusal veneers had become the most conservative treatment of the tooth structure .Lithium disilicate material has the ability of restoring severely abraded teeth [11,12]while having a high fracture resistance when bonded to tooth structure [13].It is so important to preserve the pulp vitality and prevent endodontic treatment with posts and core to decrease the healthy tooth structure cutting and harmful useless procedures.

The molars used of approximate crown size and root dimensions for decreasing possible variations and errors. Extracted human teeth were used to simulate clinical cases. [14]

Teeth were mounted in epoxy resin blocks as its modulus of elasticity value (12 GPa) is near to that of human bone (18 GPa). [15,16]

Usage of a silane coupling agent that were applied on the ceramic surface contains two different functional groups that react with inorganic matrices (hybrid ceramics), and the organic materials (resin cement), this promoting mechanical adhesion between resin cement and the restoration. [17,18]

The occlusal veneers were cemented using dual cure adhesive resin cement which had the ability to decrease the working time and made sure of curing of areas inaccessible to light[19] as done in previous studies M.Sasse et al ,2015.[11]

All restorations that can perform well and preserve its function were regarded as a success. Failure was considered with fracture or chipping this is to simulate the patient needs and comfort.[20]

Fracture resistance had influenced with the thickness of the ceramic restoration [21]. Thickness of e max CAD of 1.2–1.8 mm can withstand forces up to 1000 N and thicknesses of 0.6–1.0 mm can withstand up to 800 N . Maximum biting force was considered about 500 N accordin to different factors as age and sex[22].

Different factors control the Fracture resistance of all-ceramic restorations such as the adhesive technique used as adhesively bonded all-ceramic restorations showed a higher fracture resistance than the conventional types [23]. Total etch technique reach a bond strength of up to 28 MPa [24] in the enamel.Studies compared between the bonding process used total etch technique and using multilink primer A/B as conditioning method. Fracture resistance showed lower value with that conditioned with multilink primer. This is opposite to the results of C.Yazigi et al,2017[25] which concluded that there was no statistically difference between total etch and self etch technique this is because they used 0.8 mm thickness of occlusal ceramic veneers.

The statistical analysis revealed that a thickness of the ceramic restoration of 1.5 mm with shoulder finish line with buccal groove extention (902.55 N) gave a significant higher fracture resistance compared to without it (899.55 N) while at thickness of 1 mm without finish line and without buccal groove extension (774.57 N) as indicated by t-test (P=0.086 >0.05).when analyzing the results In all groups only the restorations with a thickness of 1.5 mm with shoulder finish line and buccal groove extention completely withstood the dynamic loading unharmed ,this is because that the increase of the ceramic thickness gave the restoration the ability to prevent the crack propagation and so fatigue resistance.

The buccal extention and the finish line enhanced more fracture resistance, this is because it increased the retention of the restoration and reassure the forces direction on the long access of the restoration.[26]

Conclusion

Usage of 1.5mm thickness buccally retentive lithium disilicate ceramic occlusal veneers can restore successfully severely abraded teeth. Preparation design with shoulder finish line increase the retention of the restoration.The thickness of 1.5 mm is more favorable especially for non retentive restorations for the fracture resistance.

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