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Fracturestrength of veneers using different restorative material, s and techniques. In vitro study

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ABSTRACT

Aim of the study*: The purpose of this study was to evaluate the fracture strength of the laminateveneers in maxillary anterior, fabricated from either composite (direct and indirect techniques) or ceramicCAD/CAM blocks.*

Materials and Methods: *Forty sound human maxillary incisor teeth were used in this in vitro study. Teeth weredivided randomly into one control group and three experimental groups of ten teeth each;*

control group

Group A*: Restored withdirect composite veneer(IPSIMPRESS),*

Group B: *Restored with indirect composite veneers (Tetric Ceram),*

Group C:*Restored with zirconia CAD/CAM block.*

Standard preparations were done using Ceramic Veneer Set. Indirect laminate veneers were cemented with the Veneer Cement and all specimenswere stored in distilled water. The load was applied on theocclusal part of the veneer at 90°tolong axis of the tooth using universal testingmachine. Results were analyzed with one-way ANOVA and LSD tests.

Specimens were examined by stereomicroscope at a magnification of 20x to evaluate the mode of failure.

Results: *Control group showed higher mean of fracture strength with highly significant difference in comparison to the experimental groups (P<0.01). (Group C) showed higher mean of fracture strength with statistically significant*

difference in comparison to (Group A and Group B). On the other hand the difference between (Group A andGroup C) was statistically highly significant. Statistically non-significant difference was found among the twogroups restored with composite restoration.

Conclusions: *All veneers used in this study can be considered as acceptable treatment in the of choice in patients with normal biting force. Direct composite veneer is the most favorable technique in term of fracturestrength, while zirconia laminate veneers are least likely to fracture and most likely to completely debond.*

Keywords: *Laminate veneers, direct composite, indirect composite, zirconia CAD-CAM,fracture strength.*

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I. Introduction:

The increasing esthetic demand of the patients and clinicians are the main reason for the search of ultimate restorative materials.

Nowadays, restorative materials isnot only to restore dental tissues lost because ofcaries or trauma, but also to correct the form andcolor of teeth for social acceptance.

Crown preparation involves significantremoval of tooth structure and may cause pulpalirritation and irreversible pulpitis. While laminate

veneers are more conservative than crowns andmaintain the biomechanics of the original tooth.(1)

Most of the veneers have a success rate of approximately 93% over 15 years of clinical use.(2)

The most frequentfailure modes associated with laminate veneers

are fracture and debonding. Fractures of laminateveneers represented 67% of the total failures ofsuch restorations over a period of 15 years of clinical performance (2,3).

II. Materials And Methods:

Forty sound human maxillary incisors were selected for the study, which were extracted due to periodontal diseases. The occluso-cervical and mesio-distaldimensions were measured. To determine that theenamel was free from cracks, all teeth werevisually examined under blue lighttransillumination. Teeth were cleaned by scalingand stored in distilled water at room temperature(4,5).

Teeth were then randomly divided into four groups of 10 specimens each:

- Control group: Intact teeth.
- Group A: Restored with direct Composite veneers\ IPS Empress
- Group B: Restored with indirect Composite veneers\Tetric Ceram
- Group C: Restored with ceramic Zirconia CAD/CAM

The teeth were mounted individually inspecially designed, locally-manufactured rubbermold (20 mm height × 20 mm diameter) with coldcure acrylic with the longaxis of the tooth parallel to center of the mold. All specimens were embedded up to 2 mmapical to the CEJ to simulate the natural biologicwidth as seen in (Fig.1).

Figure 1: Teeth mounted in acrylic block 2mm apical to CEJ.

Primary impression and primary model wasprepared for all experimental teeth which wasused to fabricate copyplast template for group A and group B, while for group C theprimary model was used to take a biocopy for creating laminate veneers of the original size andshape of the teeth**.**

A copyplast template was fabricated for eachtooth in Group A and Group B using 0.5 mmthick vacuum pressed polyethylene plastictemplate in a vacuum forming machine. Then asectional index was produced using a puttypolyvinylsiloxane material was made to evaluate the amount of tooth reduction.

Before starting, the outline of the preparationwas painted with a waterproof color marker. The tooth preparation procedure wasdone under constant water irrigation. Standardizedpreparations were done for all the teeth using ceramic veneer system preparation bur set (porcelain veneers kit Shofu). The

facial reduction was 0.4 mm at the cervical thirdand 0.5 mm at the middle and incisor thirds**.**The preparation ended 1 mm occlusal to thecement-enamel junction. Proximally,the preparation was extended without destroyingthe contact area. Where possible, all thepreparations were confined within the enamel.However, the exposure of some dentin often occurred.

This not only produces a highly predictable andstable bond, but also the enamel provides stiffnessto the tooth.

After that, all the line angles were rounded withwhite stone using slow speed handpiece.

Finally,the preparation was checkedfrom the lateralview to ensure that the necessary reduction of thefacial surface was done properly.

Final impression was taken for all teeth ingroup B and C with addition silicone impression material using two-stage putty-washtechnique. Each impression was boxed usingsheet wax and poured with type III dental stone. After setting, the die wastrimmed and numbered according to its respectivetooth.

Group A: restored with direct compositeveneers using IPS Empress. The prepared toothwas cleaned with fluoride-free pumice usingpolishing cup and then etched with 35%phosphoric acid (Scotchbond™ Etchant,3MESPE) for 15 seconds, rinse for 10 secondsand air dried gently for 5 seconds according tomanufacturer’s instructions.

Immediately afterdrying, two consecutive coats of adhesivewere applied with gentle agitation for 15 secondsusing a fully saturated brush, the adhesive thenwas gently air thin for 5 seconds to evaporatesolvent and light-cure with LED curing light(Woodpecker, China) for 10 seconds according tomanufacturer’s instructions. The labial thirdof the template was then packedwith the composite material and the template wasseated on the tooth. The excess compositeextruded from the hole was removed and thecomposite was light-cured using LED curing light for 20 secondsaccording to manufacturer’s instructions. Afterremoving the template, the veneer was finishedand polished using Optidiscs finishing and polishing system.(Shofu).

Group B: Restored with indirect compositeveneers with (Tetric Ceram). After fabrication ofthe stone die, two coat of die spacer was appliedwith a brush on the prepared part of the die (1mm) away from the margins. Standardthickness of the laminates in the original form ofthe teeth was achieved using the previously
prepared copyplast template in the same mannerused for direct composite and light cured for 10seconds. After that, the veneer was removed fromthe tooth and light cured for another 10 seconds according to manufacturer's instructions. Thethickness was checked with measuring device.
Finally, the veneer was placed on the preparedtooth and the margins were checked with dentalexplorer. After optimal fitness had been verified,the veneers were finished and polished withOptidiscs and prepared for cementation.

Group C: restored withCAD/CAM veneers (zirconia). The veneers were completed in four phases. Firstly, in "ADMINISTRATION" phase, veneer wasselected as restoration type from single restorationoptions. Maxillary first incisor tooth wasselected as abutment tooth, "bigeneric copy" was chosen as the mode of design and the type ofmaterials and manufacture (zirconia CAD CAM)defined.

Secondly, in the "SCAN" phase three dimensionalimages were obtained by scanning the models by(Dental wings 3 series scanner). Bio-copy was taken first byscanning the primary model frombuccal, mesial,and distal side to obtain three images for eachmodel, then the scanning of the die wasaccomplished by rotational scan in which the diewas fixed on the rotation mouse at 60˚, whichautomatically takes 8 snap shot for each diemodel, then only 3 images were chosen. After that,both scans were automatically analyzed andcorrelated with each other by the system whichallows alignment of the 3-dimensional image ofthe primary models on top of the 3-dimensionalimage of dies correctly. The designing of veneerwas then started in "MODEL" phase withpreparation trimming by hiding image regionsoutside the preparation, the margin of preparationwas automatically detected by the systemand in copyline section, and the area to be copiedfrom the bio-copy was delineated todesign a laminate veneer identical to the originaltooth form.
After that, other veneer parameter was definedin "DESIGN" phase such as minimum veneerthickness (0.4 mm) and spacer (8 µm) which were determined according to manufacturer'sinstructions.The milling process of the samples started asfollows: a) the selected ceramic block (zirconia blocks) was insertedin the spindle of the milling chamber of theIn Lab MC XS Dentsply miller and fastened with the setscrew.
The milling process was fullyautomated without any interference with the twodiamond cutting instrument acting togethersimultaneously in the shaping process, withcopious water cooling sprayed from bothdirections.
After completion of the millingprocess, the restoration was separated automatically,30 minutes firing cycle in a ceramic sinteringfurnace (Ivoclar/Vivadent/technical, Germany)according to manufacturer's instructions.
The internal bonding surface of indirectveneers was treated according to their manufacturers' instructions as follow:
a) Indirect composite veneers (Group B) weresandblasted with 50µm Al_2O_3 particles for 10second at maximum pressure of 2 bars (30 psi),and then cleaned by ultrasonic cleaner withdistilled water for 5 minutes.
b) zirconia CAD veneers (Group C) wasacid etch with 5 % hydrofluoric acid gel (IPSCeramic Refill) for 20 seconds washed andthoroughly with air/water spray for 30 secondsaccording to the manufacturer instructions (7). Theveneers then silanated with RelyX CeramicPrimer (3M ESPE) which was brushed onto the internal surface of the veneer and lightlyair-dried for 5 seconds to evaporate the solvent.
All indirect veneers were cemented by the 3MRelyX veneer cement using two-steps etch andrinse technique and the translucent shade cement.
Thesame procedure was followed for all indirectveneer according to the manufacturer'sinstructions of the cement. The veneers were then stored in distilled water at 37˚for 2 weeks beforetesting.
The fracture strength test performed using aUniversal Testing Machine (universaltesting machine, China). Load was applied at acrosshead speed 0.5 mm/min (5) with a customizedplunger (steel rod with a flat end 3.6 mm
diameter) attached to the upper movablecompartment of the machine (7), placed at the incisor part of the laminate veneer (16). The loadwas appliedto the long axis of the tooth.This orientation was standardized with a specially designed, locally manufactured, mounting jig(Fig. 5). The maximum load to produce fracturefor each sample was automatically recorded inNewton (N). Modes offailure were assessed with stereomicroscope at
20x magnification. The results of this study wereanalyzed with one-way ANOVA and LSD test.

Figure 5: Load applicationto the long axis of the tooth.

III. Results

The means and standard deviations of fracture strength were calculated for each group shown in (Table 1).

Table 1: Descriptive Statistics: Mean andstandard deviation of fracture strength in Newton.

Group	No.	Mean	SD	Std.error
Control	10	410.20	12.557	2.39003
Group A	10	238.20	9.750	3.08329
Group B	10	210.40	12.807	4.05024
Group C	10	320.30	7.557	2.39003

The results of this study showed that thehighest mean of fracture strength was recorded forthe control group (410.20 N), followed by group C(320.30 N), next group A(238.20), while the lowest meanvalue of fracture strength was recorded by groupB(210.40) (as shown in table 1).
ANOVA test revealed statistically highlysignificant differences among the five groups(Table 2).

Table 2: Comparison among the groupsusing one-way ANOVA test

Source of Variance	Sum of squares	Df	mean square	F	sig
between groups	241446.275	3	80482.092		
with groups	4307.700	36	119.658	672.599	0.001

Table 3: Multiple Comparisons LSD test

GP	mean difference	std.error	sig.
GroupA vs Group B	18.800	4.89200	0.00
GroupA vs Control	-172.000*	4.89200	0.00
GroupA vs Group C	-103.100*	4.89200	0.00
GroupB vs Control	-190.800*	4.89200	0.00
Group B vs Group C	-121.900*	4.89200	0.00
Group C vs Control	68.900*	4.89200	0.00

The results of ANOWA test showed that there werestatistically highly significant differences (p <0.01) among the four groups.(table 2)
The results of LSD test shows that there were statistically highly significant difference in the fracture strength of control group ascompared with the all experimental groups (A, B, and C).
Also statistically highly significantdifference was found between group C and groups.
Additionally, there were statistically significantdifferences in fracture strength between group Aand group C and between group B and group C.
On the other hand, no statistically significantdifferences were found among the direct and indirect compositegroups (Group A and B).

IV. Discussion

According to the results of this study, thecontrol group presented the highest mean fractureload among the groups, these results come inagreement with the results of Akoğlu and Gemalmaz (4), and the differencesbetween control group and other test groups werefound to be statistically highly significant.

In comparison between the mean of thedirectly restored group and the indirectly restoredgroups, the mean of fracture strength of directcomposite veneer (Group A) was statisticallysignificantly higher than that of group restored with composite indirect technique (Groups B), thiscould be explained by the elimination of cementlayer in the direct composite veneer as cement isconsidered the weak restorative link (5).Composite luting materials are vulnerable to water sorption, polymerization shrinkage, andmicroleakage (11). This finding comes inagreement with Duzyol et al. (6) results.

The fracture strength of group B was found to besignificantly lower than that of group A. Thisresult may be attributed to the effect of surfaceconditioning (sandblasting and ultrasoniccleaning) of the indirect composite veneer prior tocementation in addition to the presence of theweak cement interface. This result comes inagreement with Borba et al. (7) and Duzyol etal.(6) who found statistically highly significantdifferent between fracture strength of directly andindirectly fabricated composite veneers. Whiledisagree with Gresnigt and

Özcan(9)who foundthat direct and indirect resin composite laminateveneers showed comparable mean of fracturestrength, owing to the difference in materialsused for the construction of direct and indirectcomposite veneers.

According to LSD test there was a statisticallyhighly significant difference between group A andgroup C. However, this result disagreeswith the results Batalocco et al. (10) study in which they found that there was no significant differencein fracture strength between composite resinveneers and porcelain veneers. This may be due tothe difference in the test condition as they performed testing of the restorative materialsunder the wet condition.
The lowest mean of fracture strength presentedby group B (220.4 N), this could be attributed tothe combination of high strength (250 MPa)combined with high modulus of elasticity (10.5GPa). which translates to lower resiliency, which is the capability of the material to absorbenergy when it is deformed (8). So this mightresult in load transition to the weak link of the restoration (the cement layer.)

Failure analysis of the fractured laminates inthis study showed mainly fracture of the veneerrestoration followed by veneers debonding which coincides with the finding of Gresnigt and Ozcan(9). Clinically, these types of failure could beconsidered more favorable, since it allowsintraoral repair options. Fracture of veneers wasobserved in 100% in groups (A, B) as the dominant type of fracture. Fracture of thelaminate veneer was attributed first to the goodadhesion of the laminate veneer to either dentaltissue or the cement layer (9). Another explanationfor this could be the relatively lower flexurestrength of the materials, based on the fact that ifthe flexural strength of the veneer cannot protectthe tooth, the veneer will fracture before theloading force is transferred to the tooth (11).

Debonding of laminate veneers, on the otherhand, showed the weak link between thecement/tooth and the laminate veneer and wasobserved only in zirconia CAD group with 100% as the only mode of failure. This could beattributed to the lower resiliency of the materialwhich results in high stresses that develop directly below the loaded area at the cement interface.Interfacial stresses arise because ceramic has ahigher elastic modulus than the tooth or cement(11).A higher incidence of bond failure wasobserved at cement/veneer interface 70% and the remaining 30% of debonding was at tooth/cementinterface due to compromised bonding betweenthe resin cement and the veneer surface.

In other words, most failures are causedby complete debonding at theporcelain/cementinterface. Significant amount of crystalline debris that contaminates the porcelain surface and mayreduce bond strength by 50% and this may be considered as another explanation for the lowerbond strength at cement/ veneer interface (12).

V. Conclusion

This result indicates that both techniques direct and indirectand all the three different materials used forfabrication of laminate veneers could beconsidered strong enough to withstand normalbiting forces but forpatientswithparafunctional habit other treatment modality should be considered. Further investigation is required to study bonding of zirconia CAD veneers, which were least likely tofracture but the most likely to completely debond.

These results may provide the clinicians aguideline for the selection of restorative treatmentmodality when they provide an esthetic veneerrestoration. It has been observed that themechanical strength of the material would not bea determining factor, but other factors such aspredictable and durable esthetics, reliability of the bonding and\or the cost of treatment could be determining factors to select the specificrestoration.

References

[1]. Gresnigt M. Clinical and laboratory evaluation of laminate veneers, chapter one: Introduction. Thesis, Department of Fixed and Removable Prosthodontics, University of Groningen, Netherlands, 2011.
[2]. Friedman MJ. A 15-year review of porcelain veneer failure: a clinician's observations. Compendium of continuing education in dentistry 1998; 19(6): 625-8.
[3]. Alghazzawi TF1, Lemons J, Liu PR, Essig ME, Janowski GM. The failure load of CAD/CAM generated zirconia and glass-ceramic laminate veneers with different preparation designs. J Prosthet Dent 2012; 108(6): 386-93.
[4]. Akoğlu B, Gemalmaz D. Fracture resistance of ceramic veneers with different preparation designs. J Prostho Dent 2011; 20(5): 380-4. .
[5]. Gresnigt M, Özcan M, Kalk W. Randomized controlled split-mouth clinical trial of direct laminate veneers with two micro-hybrid resin composites. J Dentistry 2012; 40: 766-75.
[6]. Duzyol M, Seven N, Akgul N. Fracture resistance of direct and indirect laminate veneers. International Adhesive Dentistry–IAD: Beauty and science, 2013.
[7]. Borba M, Della Bona A, Cecchetti D. Flexural strength and hardness of direct and indirect composite Braz Oral Res 2009; 23(1): 5-10.
[8]. Sakaguchi RL, Powers JM. Craig's restorative dental materials, thirteenth edition, chapter four: Fundamental of materials science. USA: Mosby, Inc.\ Elsevier Inc, 2012:33-83
[9]. Gresnigt M, Özcan M. Fracture strength of direct versus indirect laminates with and without fiber application at the cementation interface. Dent Mater 2007; 23: 927-33.
[10]. Batalocco G, Lee H, Ercoli C, Feng C, Malmstrom H. Fracture resistance of composite resin restorations and porcelain veneers in relation to residual tooth structure in fractured incisors. Dental Traumatol 2012; 28: 75- 80.
[11]. Lin TM1, Liu PR, Ramp LC, Essig ME, Givan DA, Pan YH. Fracture resistance and marginal discrepancy of porcelain laminate veneers influenced by preparation design and restorative material in vitro. J Dent 2012; 40(3): 202-9.
[12]. Magne P, Paranhos MP, Burnett LH Jr, Magne M, Belser UC. Fatigue resistance and failure mode of novel-design anterior single-tooth implant restorations: Influence of material selection for type III veneers bonded to zirconia abutments. Clin Oral Impl Res 2011; 22 (2): 195-200.
[13]. Touati B, Miara P, Nathanson D, Giordano R. Esthetic dentistry and ceramic restorations. Chapter 9: Ceramic laminate veneers. London: Martin Dunitz Ltd; 1999. p. 116- 214.
[14]. Gurel G. The science and art of porcelain laminate veneers. Germany: Quintessence Publishing; 2003.
[15]. D'Arcangelo C, De Angelis F, Vadini M, D'Amario M. Clinical evaluation on porcelain laminate veneers bonded with light-cured composite: results up to 7 years. Clin Oral Investig 2012; 16(4):1071-9.
[16]. Gresnigt M, Özcan M, Kalk W, Galhano G. Effect of static and cyclic loading on ceramic laminate veneers adhered to teeth with and without aged composite restorations. J Adhes Dent 2011; 13(6): 569-77.
[17]. Archangelo CM, Rocha EP, Anchieta RB, Martin M, Freitas AC, Ko C, Cattaneo PM. Influence of buccal cusp reduction when using porcelain laminate veneers in premolars. A comparative study using 3-D finite element analysis. J Prosthod Res 2011; 55: 221-7.
[18]. IvoclarVivadentTetricceram , Scientific Documentation , University of Eriangen, Germany.
[19]. Rezvani MB, Basir MM, Mollaverdi F, Moradi A, Sobout A. Comparison of the effect of direct and indirect composite resin restorations on the fracture resistance of maxillary premolars: An in vitro study. J Dent School 2012; 29(5I): 299-305.
[20]. IvoclarVivadent. IPS Empress direct Scientific Documentation, Lichtenstein;

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