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CLINICAL EVALUATION OF DIRECT AND INDIRECT COMPOSITE RESIN RESTORATION TECHNIQUES

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Abstract

Objective: clinical evaluation of direct thermoviscus composite (Viscalor bulk) and indirect CAD/CAM composite (Grandio blocks). **Materials and Methods:** Forty molars and premolars were used and distributed randomly in 20 patients with age range (20-45). (n=20) according to restorative material used. Each composite resin restorative technique was applied according to manufacturer's instructions. All restorations were evaluated clinically at base line (after 24 h), 6, 12 and 18 months according to the modified United States Public Health Service (USPHS) for retention, marginal adaptation, marginal discoloration, secondary caries, postoperative sensitivity, color match, anatomic form and interproximal contact. **Results:** there is no significant difference for both groups in all criteria and periods of evaluation. **Conclusions:** viscalor bulk and indirect CAD-CAM composite restoration have good clinical performance. **Clinical significance:** viscalor bulk preferred to use than indirect CAD-CAM composite restoration in small class II cavities as there is no significant relation between them to avoid difficulties of indirect CAD-CAM composite restoration.

Keywords: Composite Restoration, Thermoviscous Composite, Indirect Restoration, Inlay, Computer Aided Design/Computer Aided Manufacturing.

INTRODUCTION

Resin-based composites are nowadays the best choice for posterior teeth, due to their aesthetic properties. Polymerization shrinkage is a common problem associated with light-cure composite resins. There are several options for controlling this issue, including those connected to the material and the technique [1].

Bulk fill composites have been produced; however, they are difficult to handle leads to incorrect adaptation. Preheating composite reduces shrinkage forces of composite. To avoid negative effect of preheating as loss of half of heat after two minutes of heating, a new product called viscalor bulk which is a thermo viscous bulk fill composite. it is a highly viscous composite at room temperature and converted into flowable consistency by increasing the temperature to 68° c in a special dispenser, when it contacts to tooth it becomes viscous again within short time [2].

Indirect restorations provide an alternative solution to problems associated with directly placed ones. CAD/CAM (Computer Aided Design/Computer Aided Manufacture)

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composite easily fabricated, repaired, less brittle, good marginal fit and don't make wear for the opposing natural teeth as CAD/CAM ceramic so it is widely used [3].

Grandio block is a nano-ceramic resin hybrid CAD/CAM composite block that has the highest filler content (86 %) by weight that offers physical properties that mimic natural human dentition, it also offers enhanced marginal integrity, low water sorption, enhanced color stability, allows for excellent polishability. Additional advantages are ease of use as it eliminates the firing process and allow intra oral repair [4].

The aim of this study was to evaluate clinical behavior of two composite techniques, indirect composite and direct thermoviscous composite.

Consequently, the null hypothesis of this study is to compare between two techniques, viscalor bulk as a direct composite application and grandio block CAD/CAM as an indirect composite application.

MATERIALS AND METHODS

Ethics Approval and Protocol Registration:

Benefits and difficulties of procedures were explained to the patients and informed consents were taken regarding Ethics Committee of university guidelines on human research, the ethical approval number is (R-RD-7-21-10).

The clinical study has been carried out according to the code of ethics of the World Medical Association (Declaration of Helsinki). Informed consent was obtained from everyone according to the guidelines on human research adopted by the Research Ethics Committee of the local University and received approval number (P-RD-7-22-10).

Inclusion and Exclusion Criteria:

It includes patients who exhibited good oral hygiene, normal occlusion, presence of two medium sized class II primary carious lesion with vital tooth.

Patients who demonstrated bad oral hygiene, compromised medical history, bruxism or clenshing were excluded from the study.

Sample Size Calculation:

The total sample size in this study was 40 teeth calculated using a computer program G, version 3 **at** 0.05 significance level and the post hock power sample size was 95% **.**

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Materials:

The materials, components, manufacturers and web sites used are tabulated in table **(1)**

Table 1

Materials	Description	Composition	Manufacturer	Website
Grandio blocks CAD / CAM Composite Material	Hybrid nano-ceramic composite resin block.	86% Nanohybrid Filler ,14% UDMA+ DMA	VOCO GmbH, Germany, Cuxhaven	www.voco.com
Silane coupling agent	Silane coupling agent	Methacryloxyl propyl trimemethoxysilane, ethanol, water.	Ultradent Products, Inc. South Jordan, Uath.	www.Ultradent.com
(Futurabond U) Universal Adhesive	Dual curing self-etch selective etch, technique bonding agent	Water, Ethanol, Silicium dioxide, Acid modified methacrylate. (Methacrylate ester), HEMA (2-hydroxyethyl methacrylate), Camphorquinone	VOCO GmbH, Germany, Cuxhaven	www.voco.com
Bifix QM	Dual-cured universal resin cement	Bis-GMA; benzoyl peroxide; amines.	VOCO GmbH, Cuxhaven, Germany.	www.voco.com
Provicol temporary cement	eugenol-free temporary-luting cement with calcium hydroxide	Zinc oxide, magnesium oxide, calcium hydroxide, fatty acids, vegetable oils, polyglycols, rosin, fumed silica	VOCO GmbH, Germany, Cuxhaven	www.voco.com
Aquasil Ultra smart Wetting impression material XLV	Aquasil extra light viscosity (XLV), fast set, modified siloxane	Vinyl Polysiloxane cristobalite<30, diatomaceous earth, flux-calcined<30 silica amorphous, fumed, hydrophobic<10, titanium dioxide<10	Dentsply Sirona Pty Ltd	www.dentsplysirona.com
Viscalor bulk fill	Thermoviscous, Nanohybridbulkfill composite)	Matrix: BIS/GMA (10_25%) Aliphaticdimethacrylate (2.5_5%) Inorganic filler:nano_scale filler	VOCO GmbH, Germany, Cuxhaven	www.voco.com

***BIS-GMA**: Bisphenol A diglycidyl ether dimethacrylate, **HEMA**: 2Hydroxy ethyl methacrylate, **UDMA:** Urethane dimethacr*

Patient Selection:

Forty teeth in twenty patients aged between 20- 45 years were selected. Each patient had treatment for maxillary and mandibular premolar and molar teeth.

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Study Intervention:

This study includes two groups (n=20): Group I (Grandio Indirect CAD/CAM composite inlay), Group II (Viscalor Direct thermo viscous composite).

Clinical Procedures:

Group I: cavities for inlay were prepared using special kit for inlay, with 6 to 8 degrees of divergence for facial and lingual walls.

Full arch impressions were taken with addition curing silicone impression material. and sent to the laboratory, followed by restoring the cavities with non-eugenol (Provicol) temporary restorations until the inlays were fabricated.

fitting surface of the restoration was sand blasted Then silane coupling agent was applied, Futurabond adhesive was applied to prepared cavity, Inlays were cemented using Bifix QM dual-cured composite luting material then finished.

Group II: cavities for viscalor thermoviscous composite were prepared using straight carbide fissure bur. Future bond U adhesive will be applied, viscalor bulk fill composite will be heated in a viscalor dispenser at 68° c within 30s and applied in 3-4 mm thickness as one piece , contoured according to occlusal anatomy and light cured then finishing.

- **Evaluation Procedure:**

All restorations were assessed at base line, 6, 12 and 18 months, regarding the modified United States Public Health Service (USPHS) criteria. **(Table 2)**

Table 2

Score Criteria	Alpha	Bravo	Charlie
Retention	Retained restoration		Mobility or missing
Anatomic form	The restoration is continuous with tooth anatomy and not under contoured	The restoration is.under.contoured, but.there.is.no.dentin or base exposed	Sufficient restorative material is missing so that dentin or base is exposed
Surface texture	Smooth, glazed, or glossy surface	Slightly rough or dull surface	Surface with deep pores, cannot be refinished
Color match	The restoration cannot be detected with a mirror	The restoration is visible but there is no mismatch in color, shade, and/or translucency between the restoration and the adjacent tooth structure	There is a mismatch in color, shade, or translucency but not outside the normal range of that of the tooth
Marginal discoloration	No discoloration at all margins	Shallow discoloration (localized or generalized), clinically acceptable.	Deep. discoloration (localized or generalized), clinically unacceptable

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Marginal adaptation	No visible gap, probe does not catch	Slight penetration of probe	Extensive probe penetration between cavity wall and restoration
Interproximal contact	The.contact.is.clinically sufficient; floss passes through against strong resistance	The contact is clinically acceptable: loose, but no food impactions or trauma of the papilla.	The contact is clinically not acceptable: loose contact with food impactions, and/or trauma of the papilla
Secondary caries	No evidence of recurrent caries along the margin of the restoration	Presence of softness, opacity, or white spots at the margins as evidence of undermining or demineralization, in areas where explorer catches or resists removal after insertion	
Post-operative hypersensitivity	Normal reaction to cold spray sporadic increased sensitivity	Increased cold sensitivity	Spontaneous pain

The marginal seal was confirmed by scanning electron microscope (SEM) analysis of inverse silicon replicas of 10 samples for each testing group at the whole recall periods. The detection of marginal gaps at the restoration\tooth interface was studied using SEM images.

Statistical Analysis

All data were statistically analyzed using the chi-square test and the software statistical package for the social sciences (SPSS inc, Chicago, IL, US) Version 26. P-values.

RESULT

The criteria that were tested (restoration retention, marginal seal, postoperative sensitivity, marginal discoloration, marginal adaptation, secondary caries, anatomic form, surface texture, interproximal contact and color match) were assessed regarding the modified USPHS criteria. This was done at the base line, 6 months, 12 months and 18 months' for groupI (Grandio blocs) and group II (Viscalor bulk)

For all criteria there is no clinical significance difference for both materials.

In relation to marginal adaption, there wasn't any significant difference was recorded after 12 months p-value = 0.50. Chi-square test didn't reveal any significant difference among both materials even after 18 months, (p= 0.349). It was estimated more precisely using SEM to determine the marginal seal. SEM showed minor gaps in group I at 18 months, in group II gaps were ident at 12 and 18 months demonstrating no significant difference between evaluation periods. Regarding marginal discoloration, it was only noticed in group II after 12 months, although there wasn't any significant difference among the groups (p= 0.097). At 18 months, it was detected in both tested groups with no statistically significant difference among them. (p= 0.099). Data for clinical evaluation (percentage) was illustrated in table (3).

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Table 3

Evaluation criteria materials	Scores	Baseline		After 6 months		After 12 months		After 18 months	
		GI	GII	GI	GII	GI	GII	GI	GII
Retention rate	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)
	B	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0
Marginal adaptation	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	19 (95%)	19 (95%)	18 (90%)
	B	0	0	0	0	0	1 (5%)	1 (5%)	2 (10%)
	C	0	0	0	0	0	0	0	0
Marginal discoloration	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	19 (95%)	19 (95%)	17 (85%)
	B	0	0	0	0	0	1 (5%)	1 (5%)	3 (15%)
	C	0	0	0	0	0	0	0	0
Secondary caries	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)
	B	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0
Postoperative sensitivity	A	19 (95%)	18 (90%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)
	B	1 (5%)	2 (10%)	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0
Color match	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	19 (95%)	19 (95%)	18 (90%)
	B	0	0	0	0	0	1 (5%)	1 (5%)	2 (10%)
	C	0	0	0	0	0	0	0	0
Anatomic form	A	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	19 (95%)
	B	0	0	0	0	0	0	0	1 -5%
	C	0	0	0	0	0	0	0	0
Interproximal contact	**A**	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)	19 (95%)	20 (100%)	18 (90%)
	B	0	0	0	0	0	1 (5%)	0	2 (10%)
	C	0	0	0	0	0	0	0	0

A: Alpha, B: Bravo, C: Charlie, GPI: GGrandio blocks, GPII: Viscalor bulk fill

DISCUSSION

Clinical research is very important as it gives information about real conditions and more accurate outcome or treatment.

The development of composite techniques has been adopted to control the polymerization stresses. First group was restored using Grandio block for CAD_CAM

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inlay as it provides higher degree of polymerization as they are pre-polymerized, high color stability and good marginal adaptation with no polymerization shrinkage nor microleackage. Grandio consists of ceramic filler) 86% wt) so provides higher quality of restoration [5].

The thermoviscous bulk fill composite (VisCalor bulk) selected in the current study is provided with a special heating dispenser using programme 1 setting. It was developed to compine the benefits of bulk filling with preheating. Using near infrared technology, this delivery method is said to enable homogenous warming of the highly filled VisCalor bulk fill composite. Thus, lowering its viscosity by more than 90% resulting in flow characteristics comparable to those of the flowable materials [6].

Surface conditioning to fitting surface of Grandio inlay with Sand blasting and silane coupling agent enhance the bond strength of cement to CAD\CAM composite restorative material [7,]

Class II cavity was selected in the current study. It exhibits a lower configuration factor, no marginal ridge that compensate for the polymerization stresses [8,9]

The satisfactory marginal adaptation of Grandio may be due to the high filler content (86%) and high modulus of elasticity make stresses less transmitted to tooth structure so less shrinkage, CAD / CAM blocks has higher properties than traditional indirect restorations as they are pre polymerized [10]

The improved adaptation of VisCalor composite is attributed to the heat that make the composite monomers away from each other so improve the adaptation of the material [11]

Marginal stain may be the consequence of colored molecules infiltrating the interface. It began to be observed in group II restorations at 12 months in (5%) only this was due to the presence of nano- fillers which allow good polishability that diminishes surface roughness and discoloration [12]

While in group I no marginal discoloration was observed in any restoration except (5%) recorded Bravo score after 18 months this may be due to the higher degree of polymerization and more filler content with less amount of resin since highest resin content showed more color change [13].

Secondary caries not found in any of the tested restorations throuout the duration of the study. This was due to rubber dam application which always resulted in a lower failure rate, adequate patient selection who has good oral hygiene, good marginal adaptation and the study time is considered a short period. [14]

Postoperative sensitivity was only documented at baseline in both groups, and it disappeared after a few days and was not recorded at any evaluation periods. The lack of long-term sensitivity may be attributed to the use of a sharp bur water flow, isolation with rubber dam, the use of self-etching adhesive and the application of a calcium hydroxide in deep areas [15.]

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The nearly comparable anatomic form changes with no statistically significant differences among the tested materials or during the follow up periods may be due to nano filler size which provide superior anatomic form and high wear resistance. In addition to high filler content, the surface is more resistant to wear [16].

Concerning interproximal contact evaluation, CAD-CAM blocks has better interproximal contact because contact and contour are developed outside the mouth and due to the high wear resistance of these blocks. [17]

VisCalor bulk is able to flow into the corners and margins of the box that satisfies the sealing of the proximal box as well as attains the desired anatomy. As the material rapidly cools to body temperature, it becomes packable against the matrix band for adequate interproximal contact and sculpted into functional anatomy [18,19,20.]

CONCLUSIONS

The finding indicates that Thermoviscous composite is easy to use with good results. Indirect restorations solve problems of microleakage. The results are non-significant between indirect CAD\CAM composite and viscalor.

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Conflict of Interest:

There is not any conflict of interest.

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