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Original Research Article

Clinical Evaluation of the Functional Performance of Organically Modified Ceramics (Ormocers), Nanohybrid and Microhybrid Composite in Carious Permanent Posterior Teeth Restorations

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Abstract

BACKGROUND: In recent times, resin-based direct composite restorations have become a routine and well-established procedure in dental practice, meeting the demands for aesthetics and minimally invasive restorative care. The use of resin-based composite resin for defects in posterior teeth is on the rise. A good knowledge of adhesives, composite resins and polymerization kinetics is required for the effective use of resin-based composite in patient care. **Objective:** To evaluate the functional clinical performance of an ormocer and a nanohybrid with that of a traditional microhybrid composite in carious posterior teeth restorations. **Method**: Patients with at least 3 carious lesions which required replacement (Class I and/or Class II), each with an opposing tooth were enrolled in this study. A total of 105 restorations were placed, 35 for each. **Material:** an ormocer-based composite, a nanohybrid resin composite and a microhybrid resin composite. One operator placed all the restorations according to the manufacturers' instructions with each restoration finished and polished one week after placement, the patient returned for follow-up evaluation at 1 month, 3 months, 6 months and 12 months. Two independent examiners calibrated with the web-based training called e-calib performed the evaluation using the FDI Criteria. **Results:** A total of 105 resin composite restorations, 35 restorations for each of the study materials, were placed in 35 subjects, with a female to male ratio 4.8:1. Subject recall rate was 100%. All ormocer, nanohybrid and microhybrid resin composites restorations recorded 100% clinically excellent scores from baseline to 3 months for all parameters. There was a decrease from 100% clinically excellent scores by most of the study materials, with a few recordings clinically good at 12 months. The majority of the restorations maintained clinically excellent scores from 1 month to 12 months. There was, however, no record of scores 3, 4 or 5 by any of the test materials throughout the duration of the study. **Conclusion:** The functional clinical performance of ormocer admira (voco), Tetric EvoCeram (Ivoclar Vivadent) a Nanohybrid and tetric Ceram (Excite) a microhybrid were satisfactory in the restorations of carious posterior permanent teeth restorations.

Keywords: Ormocer, nanohybrid composite, clinical evaluation.

INTRODUCTION

The search for a material that will meet the present day demands for good aesthetics and functionality has continued to generate interest in dental material sciences. Resinous materials, especially composite resins have no doubt been employed in meeting some of these demands.[1] Those who favour the use of amalgam for posterior teeth restoration have said it is due to its tolerance to a wide range of clinical placement conditions, moderate tolerance to the presence of moisture during placement, biocompatibility, durability or longevity, availability and the desirable mechanical properties (good compressive and flexural strength).[2] The disadvantages of dental amalgam, however, include increased tooth destruction during tooth preparation for macro-mechanical retention, undesirable aesthetics (silver colour) and risk of mercury toxicity.[3,4]

The availability of adhesive systems for tooth-coloured restorative materials like composite resin meant increased tooth conservation during tooth preparation.[2] Composite resin was exclusively used in the anterior region (aesthetic

zone) initially but its use has been expanded to include posterior teeth restoration with improved science of the composite resin.[5]

In contemporary times, resin-based composite restorations are common and accepted procedures in practice of dentistry.[6] However, polymerization shrinkage and technique of placement have posed some challenges to its use, despite remarkable improvements in the last few years.[6,7] In addition to the polymerization shrinkage there are also associated stresses which can result in flaws in the interface between composite-tooth bond, resulting in microleakage and failure of the bond, as well as predisposing the tooth to fracture and possible distortions of the surrounding tooth structure.[7] The amount of shrinkage is largely dependent on the matrix formulation of the composite resin and the type and the quantity of filler particles used.[8] In order to avoid some of the shortcomings of the conventional composite restorative materials, various modifications have been made to composite materials.[9] One of such led to the development of hybrid restorative material known as Organically modified ceramics (ORMOCER) in 1994.[9] Ormocers possess identical coefficient of thermal expansion to natural tooth structure; having been formulated as a new three-dimensional cross-linked inorganic-organic polymer, produced from multifunctional urethane and methacrylate alkoxysilanes as sol-gel precursors. The formation of the three-dimensional network is by the polymerization of the functional groups.[9]

The manufacturers of ormocers have argued that the greatest benefits derived from this product include, decreased polymerization shrinkage, increased wear resistance and long-term polymer stability.[10] The ormocers are thought to be excellent alternatives or replacements for amalgam.[10,11] Studies, especially laboratory, have shown some decent performance of the material, particularly as regard polymerization shrinkage,[12] wear, biocompatibility and marginal integrity.[13] Admira® (voco; Cuxhaven, Germany), an ormocer-based material was first introduced to Dental practice in 1999. It possesses three-dimensional polymerizable inorganic-organic polymer chains and aliphatic and aromatic dimethacrylates. It is made up of 79% inorganic filler, glass ceramic and $Si0_2$ particles sized 0.7um and its organic matrix is made up of ormocer, bis-GMA, UDMA and TEG-DMA.[13] It polymerizes under halogen light.[13]

An important goal of biomaterials development is to find a material that combines high mechanical stability with maximum polishability.[14] This has been accomplished by using nanoparticles in composite materials; where they enjoy patronage as nano-filler particles.[14]

There is no doubt that laboratory investigations can assist in early evaluation of a dental restoration, however, only clinical study can sufficiently identify all the likely variables which can influence the overall clinical performance of a restoration.[18] The variables comprise; abrasive forces, masticatory forces, chemically active foods and liquids, changes in temperatures, humidity fluctuation, salivary enzymes and bacterial by-products.[19,20]

Despite its deficiencies, the use of amalgam still enjoys some support.[21,22] However, composite resin is better accepted now and is gaining ground as a preferred choice of restorative material to amalgam.[23,24]

Various clinical studies are available on the clinical performance of ormocers, nanohybrid and nanofill.[25,26,27,28,29,30]
The aim of the present study therefore, was to evaluate the Functional performance of an ormocer, a nanohybrid and that of a traditional microhybrid composite in carious permanent posterior teeth restorations.

MATERIALS AND METHODS

Ethical approval was sought and obtained from the Ethics and Research Committee prior to commencement of participants recruitment for the study. The study design was a hospital based prospective randomized control study and was carried out at the Conservative dentistry unit of the Department of Restorative Dentistry, University of Benin Teaching Hospital (UBTH) Benin City, Edo State, Nigeria.

The study population consisted of patients aged 18 years and above who presented in the Conservative clinic of University of Benin Teaching Hospital, with Class I, Class II carious lesions, and existing amalgam fillings on the posterior teeth requiring replacements.

Data Collection

Data were collected using the data collection sheet which consisted of six (6) sections; Socio-demographics, medical and drug history, dietary habits, oral hygiene habit, oral examination, treatment and follow-up.

For baseline data, the number of teeth in the patient‘s mouth was noted. The number of teeth with dental caries and the size, site and extent of the lesion based on the Federal Dental International (FDI) criteria were also documented.

1. Method of diagnosis was clinical (visual/tactile examination under well-lit environment) and radiographic assessment.
2. Data form: Bio-data and relevant history obtained from patient were entered into a data form. Pre-treatment assessment, treatment given and thereafter, recall and follow up findings were also entered into this data form. The subjects were recalled at 1 month, 3 months, 6 months and 12 months. Some of the information noted before treatments were; name, age, gender, address, telephone number, occupation and presenting complaints.

Investigations carried out were periapical radiographs for deep carious lesions, bite wing radiograph for inter-dental carious lesion. Thermal and electrical pulp testing were used to ascertain the sensibility of the teeth where necessary.

All these variables; tooth locations, type of material used, together with post-operative evaluation were recorded in the data form. The number of teeth with dental caries and the size, site and extent of the lesion based on the Federation Dental International (FDI) criteria were also noted.A systematic random sampling technique was utilized for this study.

The resinous composite materials that were used in this study were, an ormocer-based composite, Amira/Admira® bond; a nanohybrid resin composite, tetric EvoCeram/Excite® and a microhybrid resin composite, tetric Ceram/Excite®

Clinical Procedure

Each participant received all three restorative materials used in this study. A total of 105 occlusal/proximo-occlusal restorations using Ormocer, Nanohybrid and traditional microhybrid composites were carried out. All teeth were treated by the researcher alone. The teeth were prepared using conventional instruments and adhesive conservative techniques. The shade of the composite resin was selected, making use of the shade guide provided by the manufacturer.

Restorative Procedure

Local anesthetic was administered before cavity preparation to prevent patient discomfort during the restorative procedures only for patients who had medium sized cavities. The average facio-lingual width of the cavities was approximately one third of the intercuspal width. No beveling was performed.

After cavity preparation the operative field was isolated using rubber dam or cotton rolls together with suctioning. Calcium hydroxide (Dycal) was only used in deep preparations and applied directly over the deep portion of the preparation. This was then sealed with a glass ionomer cement lining.[15] Class II preparations were restored using a matrix band that was fixed with a retainer. For all restorations, two-step etch-and-rinse adhesive systems were used (Admira Bond, Voco) for ormocer, excite (ivoclar Vivadent) for nanohybrid composite, and Excite (Ivoclar Vivadent) for microhybrid composite.

Thirty-seven percent (37%) phosphoric acid gel was used to etch the preparations for ormocer, nanohybrid and microhybrid. The acid gel was first placed on the enamel and then the dentin was conditioned during the last 15 seconds of the 30-second etching time. Each preparation was then thoroughly rinsed with water for 10 seconds and dried (without dessication) to give a frosty white appearance. The adhesive was applied for 30 seconds using a microbrush. The solvent was removed using a gentle air stream after 10 seconds and this was followed by polymerization for 10 seconds using LED. The wavelength of the unit was between 400 and 500 nm.

Restoration of preparations was incrementally made in oblique layers with ormocer, nanohybrid, or microhybrid resin composite. Each increment was light-cured for 40 seconds. After removing the matrix band, the proximal regions of the restorations were additionally polymerized buccally and lingually/palatally for 40 seconds. At the same appointment contouring and finishing of the restorations were carried out using a water-cooled, fine-grit diamond finishing instrument. Articulating paper was used to assess appropriate occlusal morphology and contact. Flexible points impregnated with silicone dioxide were used to obtain smooth surfaces. For finishing and polishing of the proximal surfaces, aluminum oxide finishing strips were used. The quality of the interproximal contacts was checked with dental floss.

Evaluation of restorations

All restorations were clinically evaluated at baseline, after one (1) month, three (3) months, six (6) months and 12 months by 2 examiners who were calibrated using e-calib web-based training.[31] The world dental federation (FDI) criteria[32] was used for the clinical evaluation. The FDI criteria which were approved in 2007 have been in use since then. It is categorized into three groups: aesthetic parameters which have four criteria, functional parameters with six criteria and biological criteria having six parameters. Each criterion was expressed with five scores, three for acceptable and two for non-acceptable. Under the non-acceptable, one was for reparable and one for replacement. The two blinded examiners involved in the evaluation were not part of the restorative procedure.

In the FDI grading assessment, score 1 means that the quality of the restorations is excellent/fulfills all quality criteria and the tooth or surrounding tissues are adequately protected.[32] Score 2 is selected when the quality of restoration is still highly acceptable though one or more criteria deviate from the ideal. Score 3 means that the quality of the restoration is sufficiently acceptable but with minor shortcomings. The restoration is scored 4 when it is not acceptable but reparable while score 5 is unacceptable requiring replacement

The clinical assessments were carried out by experienced, calibrated examiners who were not involved in the placement of the restorations. There was no patient drop out from the study.

DATA ANALYSIS

The questionnaires were screened for completeness by the researcher, coded and entered into the IBM SPSS Version 21.0 software and analyzed. Univariate analysis was carried out on categorical data such as sex, religion, educational status, marital status and presented as frequencies and percentages. Numerical data such as age that were normal in distribution were expressed as means ± standard deviation and continuous data that were skewed in distribution were expressed as median (range). Test of association between two nominal variables was done using the Chi square. However, Fisher's exact test was done, when the assumptions for the chi square test was not met. The level of all statistical association was set at $p< 0.05$. Kappa Cohen inter examiner reliability score was 0.9

RESULTS

Thirty-five participants were recruited into this study. Of the 35 participants, 29 (82.9%) were females while 6 (17.1%) were males, giving a female to male ratio of 4:1. Each participant had 3 cavities which were restored with each of the test materials, giving a total of 105 restorations. All 35 participants in this study were available throughout the duration of the study, giving a 100.0% recall rate.

Table-1: Socio-demographic characteristics of the study participants

Characteristics	Frequency (n = 105)	Percentages
Age group (years		
<20	9	8.6
20-30	60	57.1
31-40	21	20.0
41-50	12	11.4
>50	3	2.9
Sex		
Male	18	17.1
Female	87	82.9
Highest level of education		
Secondary	9	8.6
Tertiary	96	91.4

Table 1 shows that, of the 105 restorations placed, female participants received the majority, 87 (82.9%) while 18 (17.1%) were placed in cavities of male participants. More than two-third (57.1%) of the restorations were placed in cavities of participants within the age group of 20-30 years while participants in the age group >50 years received the least number (2.9%) of restorations. Greater proportion, 96(91.4%) of the restorations were placed in cavities of participants whose highest level of education was tertiary.

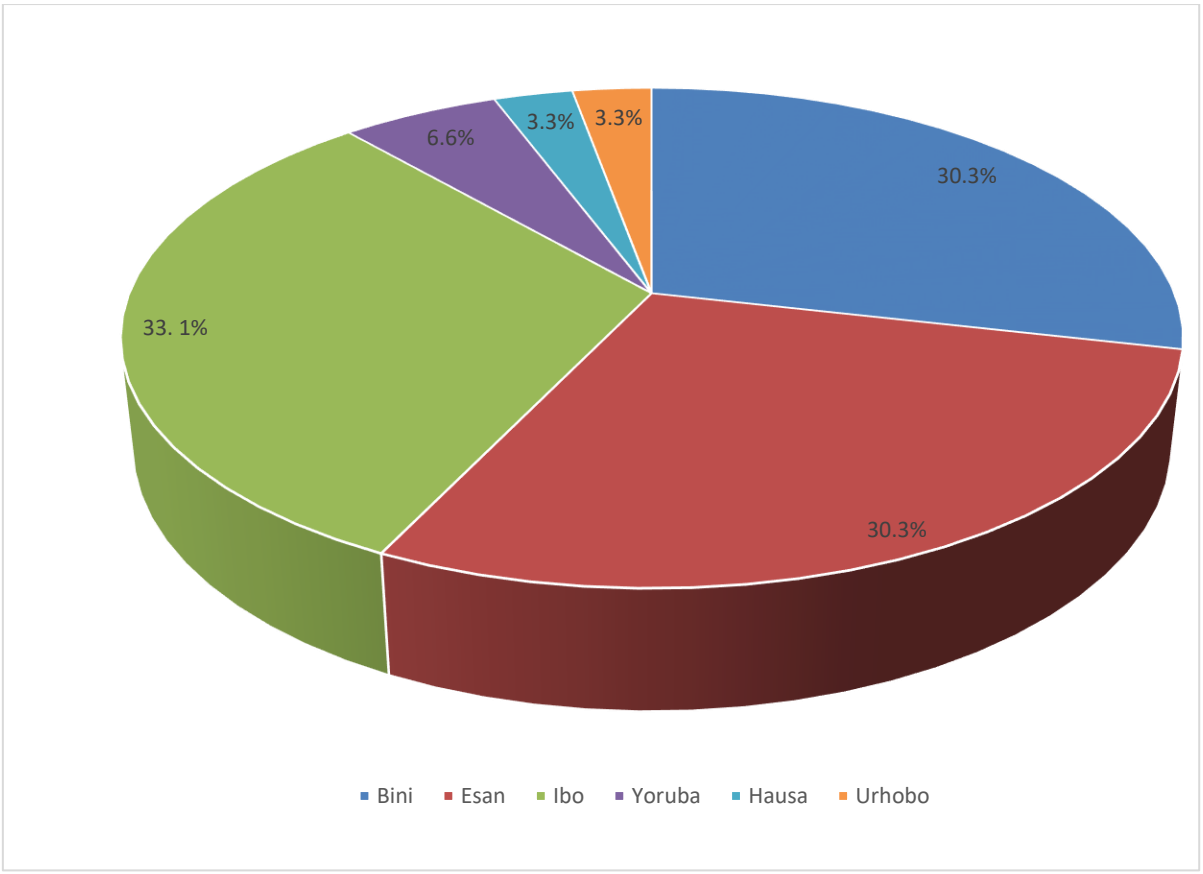

Fig-1: Tribe of the study participants

Fig-1: represent the tribes of the study participants. Bini recorded the highest percentage of participants, 33.1%, with Hausa and Yoruba having the least number 3.3% each.

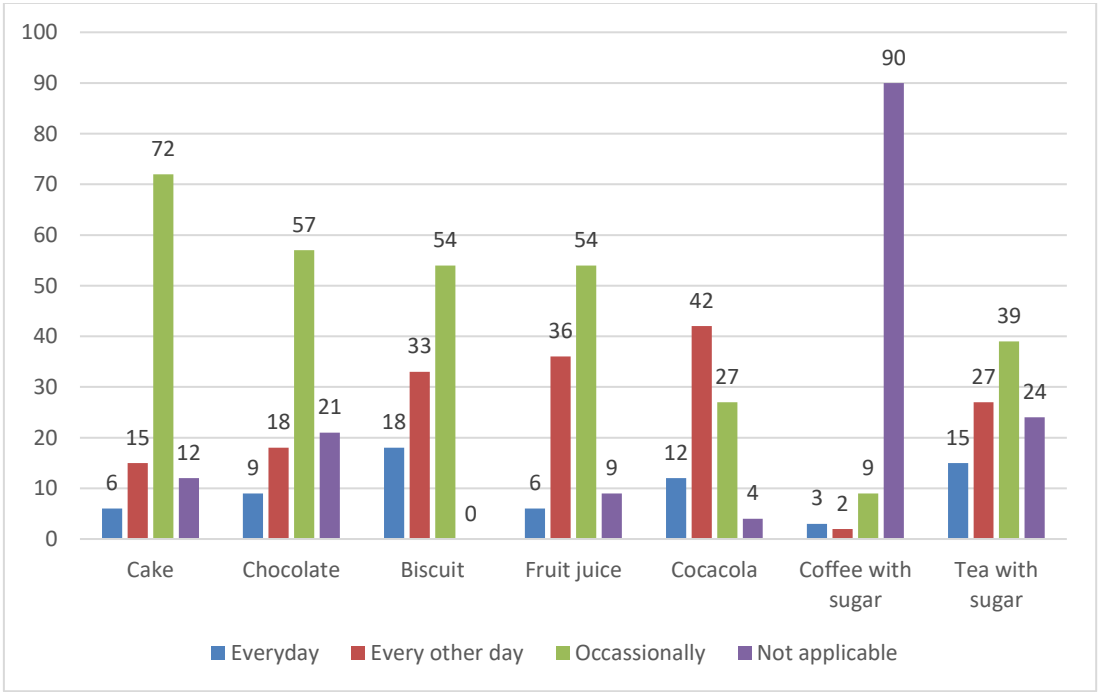

Fig 2: Dietary pattern of study participants

The dietary pattern of the participants in the study is depicted in fig 2. Majority of participants reported taking one form of snacks or the other. Majority (72%) of those who took cake claimed they did so occasionally. Of those who reported taking chocolate, 57% claimed they did so occasionally and 54% of those who stated they took biscuits also claimed they did so occasionally. Daily consumption of fruit in the form of juice was reported by 6% of the participants while 12% claimed they consumed Coca-Cola on a daily basis. Majority (54%) of those who consumed fruit juice claimed they did so occasionally, 42% of those who consumed Coca-Cola reported doing so every other day. . Majority (90%) claimed they did not consume coffee with sugar at all while only a few (24%) of the study subjects did not take tea with sugar at all. However, 39% of the study participants who consumed tea with sugar claimed they did so occasionally. All participants consumed biscuit.

Table-2: Distribution of Cavity Types

	Class I	**Class II**	**Total**	**P value**
Distribution	**n (%)**	**n (%)**	**n (%)**	
Tooth type				
Maxillary premolar	6 (40.0)	9 (60.0)	15 (100.0)	
Mandibular premolar	2 (100.0)	0 (0.0)	2 (100.0)	
Maxillary molar	36 (90.0)	4 (10.0)	40 (100.0)	
Mandibular molar	44 (91.7)	4 (8.3)	48 (100.0)	**0.000***
Gender				
Male	17 (94.4)	1 (5.6)	18 (100.0)	
Female	71 (81.6)	16 (18.4)	87 (100.0)	0.136
Test material				
Nanohybrid	27 (77.1)	8 (22.9)	35 (100.0)	
ORMOCER	27 (77.1)	8 (22.9)	35 (100.0)	
Microhybrid	34 (97.1)	1 (2.9)	35 (100.0)	**0.013***
Cavity size				
Small (1-4mm)	74 (84.1)	14 (15.9)	88 (100.0)	
Medium (5-8mm)	14 (82.4)	3 (17.6)	17 (100.0)	0.860

Statistical significance=*

Table 2 shows the distribution of cavity types. The distribution of cavity types according to types of teeth and jaw was statistically significant (p=0.000) Majority of class 1 cavities were on molars with 36 (45.0%) located in the maxilla compared to 44 (55.0%) located in the mandible. More,6 (40.0%) class 1 cavity on premolars were located in the maxilla.

Concerning gender and cavity types, the table shows that female recorded majority, 71(81.6%) of class 1 and 16(18.4%) of class 11 compared to male who had 17 (94.4%) of class 1 and 1 (5.6%) of class 1. (p value = 0.14)

The relationship between the distribution of the test materials used and the types of cavity restored was statistically significant (p=0.013). It showed that, of the 35 teeth restored with Nanohybrid, 27(77.1%) were class 1 while 8(22.9%) were class 11. Similarly, ORMOCER was used to restored the same proportion of cavities as seen in Nanohybridrecorded same, 27(77.1%) and 8(22.9%) for class 1 and class 11 respectively. However, Microhybrid was used to fill 34(97.1%) class 1 restorations compared to 1(2.9%) class 11 filled with Microhybrid composite resins.

Majority, 74(84.1%) of the small size cavities were class 1 while 14(15.9%) were class 11. Of the medium size cavities, 14(82.4%) were class 1 while 3(17.6%) were class 11(p value 0.860)

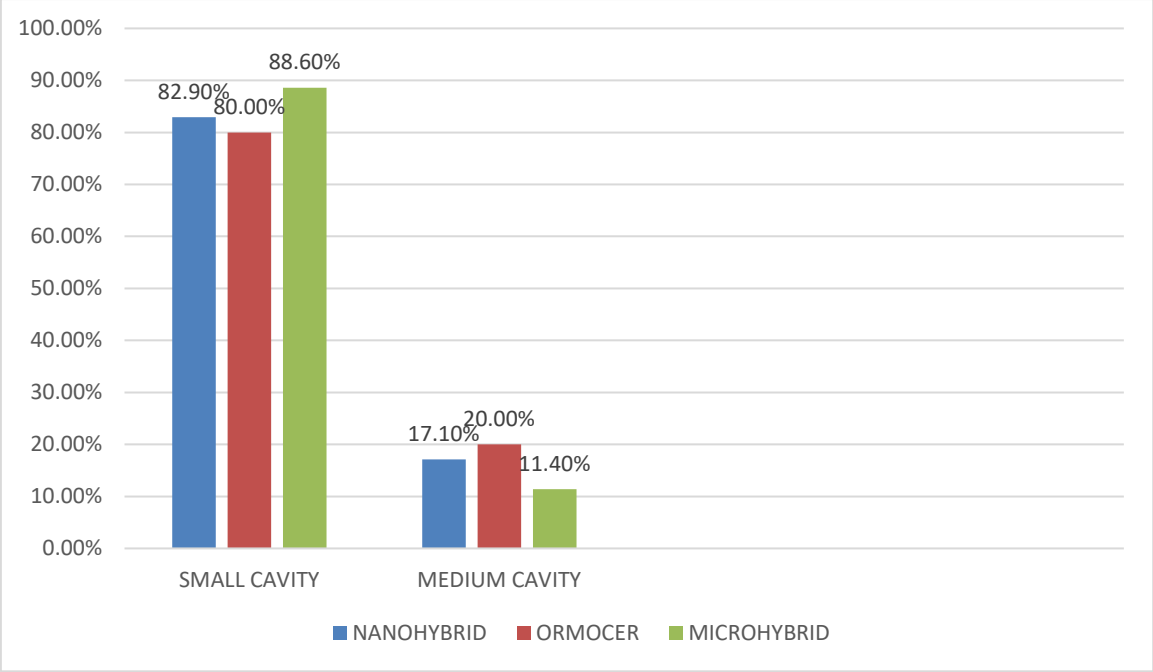

Fig-3: Distribution of test materials among cavity sizes

Fig 3: depicts the cavity sizes and the test material used. The fig showed that the three study materials were fairly evenly distributed among the small and medium size cavities. Microhybrid restorations were slightly more (88.6%) compared to Nanohybrid(82.9%) and ORMOCER which had 80.0% placed in small cavities. More (20.0%) ORMOCER were placed in medium size cavities.

CRITERIA	SCORE	EVALUATION	PERIODS				
		BASELINE n (%)	1MONTH n (%)	3MONTHS n (%)	6MONTHS n (%)	12MONTHS n (%)	P-VALUE
FRACTURE & RETENTION OF MATERIAL	1	35 (100.0)	35 (100.0)	35 (100.0)	34 (97.1)	33 (94.3)	0.204
	2	-	-	-	1 (2.9)	2 (5.7)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
MARGINAL ADAPTATION	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
WEAR	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PROXIMAL ANATOMIC FORM	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	34 (97.1)	NA
	2	-	-	-	-	1 (2.9)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
RADIOGRAPHIC	1	35 (100.0)	35	35 (100.0)	35(100.0%)	35 (100.0)	NA

EXAMINATION			(100.0)				
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PATIENT'S VIEW	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
FINAL FUNCTIONAL SCORE	2						

The functional parameters of Nanohybrid are depicted in table 3 above. There were no statistically significant differences in fracture and material retention, marginal adaptation, wear, proximal contact point, radiographic examination and patients view between baseline and 12 months for Nanohybrid. ($p>0.05$). The proportion of Nanohybrid restorations that scored 1 decreased from 100% to 97.1% and then to 94.3% at 6 and 12 months respectively for the parameter fracture of material however, this was not statistically significant ($p=0.204$). Other functional parameters recorded 100% score of 1 throughout the evaluation periods. The final functional score was 2, which is clinically acceptable score.

Table-4: Functional Parameters of Ormocer

CRITERIA	**SCORE**	**EVALUATION PERIODS**					
		BASELINE n (%)	1MONTH n (%)	3MONTHS n (%)	6MONTHS n (%)	12MONTHS n (%)	P-VALUE
FRACTURE & RETENTION OF MATERIAL	1	35 (100.0)	35 (100.0)	35 (100.0)	34 (97.1)	34 (97.1)	0.448
	2	-	-	-	1 (2.9)	1 (2.9)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
MARGINAL ADAPTATION	1	35(100.0)	35 (100.0)	35(100.0)	34 (97.1)	34(97.1)	0.448
	2	-	-	-	1(2.95)	1(2.9)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
WEAR	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PROXIMAL ANATOMIC CONTACT POINT	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
	2	-	-	-	2(5.7)	2 (5.7)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
RADIOGRAPHIC EXAMINATION	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PATIENT'S VIEW	1	35 (100.0)	35 (100.0)	35(100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
FINAL FUNCTIONAL SCORE	2						

Table 4 evaluated the functional parameters of ORMOCER between baseline and 12 months. There was no statistically significant difference in the functional performance of ORMOCER between baseline and 12 months ($p>0.05$). One ORMOCER restoration had a deterioration (score 2) for the parameters fracture and material retention and marginal adaptation at 6- and 12-months evaluation periods. There was a change in proximal contact points at 6 and 12 months from 100% to 94.3% score of 1 while 2(5.7%) scored 2. This is clinically acceptable. However, wear, radiographic examination and patient's view did not change from 100% score of 1 throughout the evaluation periods.

Table-5: Functional Parameters of Micro hybrid

CRITERIA	SCORE	EVALUATION	PERIODS				
		BASELINE n (%)	1MONTH n (%)	3MONTHS n (%)	6MONTHS n (%)	12MONTHS n (%)	P-VALUE
FRACTURE & RETENTION OF MATERIAL	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
	2	-	-	-	2 (5.7)	2 (5.7)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
MARGINAL ADAPTATION	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
	2	-	-	-	2 (5.7)	2 (5.7)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
WEAR	1	35 (100.0)	35 (100.0)	35(100.0)	35(100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PROXIMAL ANATOMIC CONTACT POINT	1	35 (100.0)	35 (100.0)	35 (100.0)	34 (94.3)	32 (91.4)	0.073
	2	-	-	-	1 (2.9)	3 (8.6)	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
RADIOGRAPHIC EXAMINATION	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PATIENT'S VIEW	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
FINAL FUNCTIONAL SCORE	2						

Table 5 presents the functional parameters of Microhybrid during the evaluation periods. Fracture and retention of materials and loss of marginal adaptation scored 2 for two Microhybrid restorations. The anatomic approximal contacts of three microhybrid restorations had a score of 2(clinically good) at 12 months. There was a slight deterioration from 100.0% to 94.3% in score of 1 with 2(5.7%) restorations scoring 2 for fracture of material and marginal integrity at 6 and 12 months. These changes were however not statistically significant between baseline and 12 months of recall visits ($p>0.05$). The scores for Wear, radiographic examination and patients view remained unchanged throughout the evaluation periods. The final functional parameters score for microhybrid was 2.

Table-6: Comparison of Functional Performance of the Test Materials

Evaluation period	Scores	Performance of materials			
		NANOHYBRID n (%)	ORMOCER n (%)	MICROHYBRID n (%)	P-VALUE
1 MONTH					
	1	35(100.0)	35(100.0)	35(100.0)	NA
	2	0(0.0)	0(0.0)	0(0.0)	
3 MONTHS					
	1	35(100.0)	35(100.0)	35(100.0)	NA
	2	0(0.0)	0(0.0)	0(0.0)	
6 MONTHS					
	1	34(97.1)	31(88.6)	30(85.7)	
	2	1(2.9)	4(11.4)	5(14.3)	
12 MONTHS					
	1	32(91.4)	31(88.6)	28(80.0)	
	2	3(8.6)	4(11.4)	7(20.0)	
TOTAL		35(100.0)	35(100.0)	35(100.0)	

Summary Table Showing The Number Of Restorations That Scored 2 At 6 And 12 Months For Functional Performance Of Test Materials

	Nanohybrid	ORMOCER	Microhybrid
6 Months	1	4	5
12 Months	3	4	7

Table 6 compared the functional performance of the study materials. There was no statistically significant difference in the functional performance of the study materials ($p>0.05$). However, there were 4(11.4%) of ORMOCER restorations that scored 2 each at 6 and 12 months compared to the number, 1(2.9%) of Nanohybrid and 3(8.6%) that scored 2 at 6 and 12 months. Five (14.3%) and 7(20.0%) of Microhybrid restorations scored 2 at 6- and 12-months evaluations respectively.

DISCUSSION

The present study evaluated the functional clinical performance of an ORMOCER (Admira voco) and a light cured nanohybrid (tetric Evoceram, Ivoclar Vivadent)) with microhybrid (tetric Ceram,Excite) acting as control in carious posterior permanent teeth restorations in adult patients over a 12- month period. The three composite materials performed similarly in every aspect of the assessment over the 12 months evaluation period using the more sensitive and detailed FDI criteria.[32]

The functional parameters of Nanohybrid restorations, in the present study recorded 100% score of 1 (clinically excellent) for the parameters; marginal adaptation, wear, radiographic examination and patients view throughout the study duration while fracture and retention of material and proximal contact points recorded 94.3% and 97.1% score of 1, 5.7% and 2.9% score of 2 for the respective restorations at 12 months. In a study which evaluated the clinical performance of Nanohybrid and Microhybrid using the FDI criteria,[33] 100% score of 1 was recorded for the functional parameters (fracture and retention, wear, radiographic examination) while one restoration scored 2 at 12 months for the parameter, proximal contact point. This finding is in agreement with the result of the present study. Others studies reported contrary findings.[33,34] In one study,[35] twenty-eight Nanohybrid restorations presented with good margins (score 2) while 8 had excellent margins (score 1) at 12 months and for patients view there was a 100.0% score of 1 throughout the duration of the study. All were clinically acceptable. The reason for the increased deterioration in marginal adaptation recorded in this study could probably be due to high polymerization shrinkage stress. In another

study, a 30-Month randomised clinical trial to evaluate the clinical performance of a nanofill and a nanohybrid,[36] 85.4% of the Nanohybrid restorations evaluated at 12 months presented with 'excellent' marginal adaptation (score 1) while 12.2% presented with 'good' margins (score 2). The difference in percentage score may have been due to polymerization shrinkage or degradation of the resin/bond interface as a result of slow water hydrolysis. This is in contrast to the present study which recorded 100% score of 1 for the same parameter.

The clinical performance of the functional parameters of ORMOCER was evaluated over 12-month period and was found to be clinically acceptable. Only one ORMOCER restoration each scored 2 for the specific criteria of fracture and material retention and marginal adaptation while 2 ORMOCER restorations scored 2 for proximal contact at 12 months. This is indicative of slight reduction in function of ORMOCER between baseline and 12-month evaluation periods. This was however not statistically significant ($p>0.05$) despite the numerical difference in the restorations scoring 1 or 2. The change in scores may be attributed to polymerization shrinkage and faulty adaptation of material during placement. A study[25] which also evaluated the clinical performance of ORMOCER, reported a similar finding in the marginal adaptation of the restorations with ORMOCER where the scores recorded changed from 1 to 2 at 6 and 12 months. The study[25] however reported 100% excellent score for fracture and retention of the restorative material at end of 12-month evaluation period. This is in contrast with the finding of the present study, in which 34 (97.1%) of ORMOCER restorations scored 1 at 12 months for fracture and retention of material. The slight deterioration in fracture and retention of material and marginal adaptation may have been due to chewing hard substances and polymerization shrinkage experienced by the material. A study[34] which examined the clinical performance of ORMOCER, reported excellent results regarding marginal adaption after 6 months. Evaluation of the clinical performance of the biological parameters of ORMOCER restorations revealed that there was slight deterioration in 2 ORMOCER restorations for post-operative hypersensitivity at 6 and 12 months while there was one and three ORMOCER restorations with recurrent caries at 6 and 12 months respectively. Two restorations had a slight enamel marginal split for the parameter, tooth integrity at 6 and 12-months compared to the performance recorded at baseline, 1 month and 3 months. However, this deterioration was not statistically significant. A 100% excellent clinical performance was recorded for the other biological parameters. The slight deterioration in the parameters post-operative hypersensitivity and recurrent caries could be attributed to the procedure involved in the restoration rather than the material characteristics.[37,38]

.The functional parameters of Microhybrid were evaluated between baseline and 12 months. The result showed that the scores for the parameters; fracture and retention of material and marginal adaptation of microhybrid restorations changed from 100.0%-94.3% excellent score at 12 months with 5.7% of the restorations scoring 2. The score for proximal contact point of 3(8.6%) of microhybrid restorations was 2 at 12 months of evaluation. These scores were different from the 100.0% score of 1 obtained for wear, radiographic examination and patients view throughout the duration of the study. A study[35] that evaluated the clinical performance of microhybrid and nanohybrid, a score of 2 was assigned to 77.8% of microhybrid restorations compared to score of 1 recorded by 22.2% restorations for the parameter marginal adaptation. This is contrary to the finding of the present study where majority (94.3%) of the restorations were assigned a score of 1 for the functional parameter, marginal adaptation. Mahmoud et al[25] reported 100% excellent score for fracture and material retention and marginal adaptation. This is higher compared to the present study which observed a change in the fracture and material retention and the marginal adaptation of the Microhybrid restorations at 6 and 12 months compared to the earlier evaluation periods.

Conclusion

Based on the findings of this study, the use of a more sensitive criteria and despite the short evaluation period, one can conclude that ORMOCER (Admira voco) and a light cured Nanohybrid (tetric Evoceram, Ivoclar Vivadent)) with Microhybrid (tetric Ceram,Excite have displayed similar clinical performance over an evaluation period of 12 months.

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