CLINICAL EVALUATION OF THE FUNCTIONAL PERFORMANCE OF ORGANICALLY MODIFIED CERAMICS (ORMOCERS), NANOHYBRID, AND MICROHYBRID COMPOSITE IN 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 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 to effectively use composite in patient care.

OBJECTIVE: To compare the functional clinical performance of an ormocer and a nanohybrid to that of a traditional microhybrid composite in posterior teeth restorations.

MATERIAL AND METHOD: Patients with at least three 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. The materials used for this study included an ormocer-based composite, a nanohybrid resin composite, and a micro-hybrid resin composite. One operator placed all the restorations according to the manufacturers' instructions. Each restoration is finished and polished immediately after placement. The patient returned for follow-up evaluation at one(1)month, three (3)months,six6 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 of 4.8:1. The subject recall rate was 100%. All ormocer, nanohybrid, and micro-hybrid resin composites restorations recorded 100% clinically excellent scores from baseline to 3 months for all parameters. Most of the study materials showed a decrease from 100% clinically excellent scores, with a few recordings clinically good at 12 months. At least one restoration of each material experienced a deterioration of the parameters, fracture, retention of materials, and proximal anatomic form.
The functional clinical performance of ormocer admira (voco), Tetric EvoCeram (Ivoclar Vivadent), a Nanohybrid, and tetric Ceram (Excite), a micro-hybrid were satisfactory in the restorations of carious posterior permanent teeth.
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 study.

CONCLUSION: The functional clinical performance of ormocer admira (voco), Tetric EvoCeram (Ivoclar Vivadent), a Nanohybrid, and tetric Ceram (Excite) micro-hybrid were satisfactory in the restorations of posterior permanent teeth restorations.

KEYWORDS: Ormocer, nanohybrid composite, clinical evaluation.

INTRODUCTION

The search for a material that will meet the present-day demands for pleasing aesthetics and functionality has continued to generate interest in dental material sciences. Resin composites and adhesives are considered state of the art in today's restorative dentistry.[1] This has led to a paradigm shift away from the use of amalgam towards the more tooth-structure preserving tooth-coloured restorative materials like composites.[2] Resinous materials, especially composite resins, have undoubtedly been employed to meet some of these demands.[3] 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 desired mechanical properties (good compressive and flexural strength).[4] The disadvantages of dental amalgam include increased tooth destruction during tooth preparation for macro-mechanical retention, undesirable aesthetics (silver color), and risk of mercury toxicity.[5,6]

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 restorations with improvements in the composition of the composite resin.[7]

A recent development in adhesive systems is universal adhesives (Uas). They are one-step SE adhesives (removed, which can be applied using an etch-and-rinse), self-etch, or selective enamel-etch mode.[8] This allows dentists to select their adhesive technique according to their preference and the clinical situation.[9,10] Universal adhesives range from ultra-mild (pH ≥ 2.5) to mild (pH ≈ 2) and contain functional phosphate and/or carboxylate monomers that can bond chemically to dental tissues.[7, 11] Existing data, have shown that the two-step SE adhesives form a more stable bond and durable restorations than the simplified SE adhesives.[12]

In contemporary times, resin-based composite restorations are common and accepted procedures in the practice of dentistry.[13] However, polymerization shrinkage and technique of placement have posed some challenges to its use, despite remarkable improvements in the last few years[13,14] In addition to the polymerization shrinkage, there are also associated polymerization shrinkage 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.[14] 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.[15] To avoid some of the shortcomings of the conventional composite restorative materials, various modifications have been made to their composition.[16]

One of such led to the development of hybrid restorative material known as Organically modified ceramics (ORMOCER) in 1994.[16] Ormocers possess an 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.[16]

The manufacturers of ormocers have argued that the most significant benefits derived from this product include decreased polymerization shrinkage, increased wear resistance, and long-term polymer stability.[17] The ormocers are thought to be excellent alternatives or replacements for amalgam.[17.18] Studies, especially laboratory, have shown some decent performance of the material, particularly polymerization shrinkage,[19] wear, biocompatibility, and marginal integrity.[20] 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 SiO_2 with an average particle size of 0.7um, and its organic matrix is made up of ormocer, bis-GMA, UDMA, and TEG-DMA.[13] It polymerizes under halogen light.[20]

An important goal of biomaterials development is to find a material that combines high mechanical stability with maximum polishability.[21] This has been accomplished by using nanoparticles in composite materials; where they enjoy patronage as nano-filler particles.[21]

There is no doubt that laboratory investigations can assist in the early evaluation of dental restoration; however, the only clinical study can sufficiently identify all the likely variables that can influence a restoration's overall clinical performance.[22] The variables comprise; abrasive forces, masticatory forces, chemically active foods, and liquids, temperature changes, humidity fluctuation, salivary enzymes, and bacterial by-products. [23, 24]

Despite its deficiencies, amalgam still enjoys some support.[25, 26] However, composite resin is better accepted now and is gaining ground as a preferred choice of restorative material to amalgam.[27,28]

Various clinical studies are available on the clinical performance of ormocers, nanohybrid, and nanofill.[29-34]

Therefore, the present study aimed to evaluate and compare the functional performance of an ormocer and a nanohybrid to that of a traditional microhybrid composite in permanent posterior teeth restorations.

MATERIALS AND METHODS

Ethical approval was sought and obtained from the Ethics and Research Committee before participants' recruitment for the study. The study design was a hospital-based prospective randomized control study 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 the University of Benin Teaching Hospital with Class I and 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 habits, oral examination, treatment, and follow-up.

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

1. The method of diagnosis was clinical (visual/tactile examination in a well-lit environment) and radiographic assessment.

2. Data form: Bio-data and relevant history obtained from the patient were entered into a data form. Pre-treatment assessment, treatment given, and recall follow-up findings were also entered into this data form. The subjects were recalled at one(1) month, three(3) months, six(6) months, and twelve(12) months. Some of the information noted before treatment were; name, age, gender, address, telephone number, occupation, and presenting complaints.

Investigations carried out were periapical radiographs for deep carious lesions and bitewing radiographs for inter-dental carious lesions. Thermal and electrical pulp testing were used to ascertain the vitality of the teeth where necessary.

All these variables, tooth locations, and 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; (voco, Cuxhaven, Germany), a nanohybrid resin composite, tetric EvoCeram/Excite® (voco, Cuxhaven, Germany) and a micro-hybrid resin composite, tetric Ceram/Excite®(voco, Cuxhaven, Germany)

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. One researcher treated all teeth. The teeth were prepared using conventional instruments and conservative adhesive techniques.

The shade of the composite resin was selected using the shade guide provided by the manufacturer.

Restorative Procedure

Local anesthetics were administered before cavity preparation to prevent patient discomfort during the restorative procedures only for patients who had medium-sized cavities because of possible dentinal exposure, which could result in dentin hypersensitivity during cavity preparation. The average facio-lingual width of the cavities was approximately one-third of the intercuspal width. No bevelling was performed. Small cavities measured between 1 and 2mm facio-lingually while medium-size measured >2mm but less than 4mm.

After cavity preparation, the operative field was isolated using a rubber dam and cotton rolls together with suctioning.[1] (removed 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.[35] Class II preparations were restored using a plastic 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 (Tetric EvoCeram) for nanohybrid composite, and Excite (Ivoclar Vivadent) for microhybrid composite.

Thirty-seven percent (37%) phosphoric acid gel was used to etch the ormocer, nanohybrid, and micro-hybrid preparations. 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 desiccation) to give a frosty white appearance for the etched enamel. The adhesive was applied for 30 seconds using a micro brush. The solvent was removed using a gentle air stream after 10 seconds, and this was followed by polymerization for 10 seconds using LED light. 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 40seconds. 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 (removed 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 two(2) examiners who were calibrated using e-calib web-based training.[36] The world dental federation (FDI) criteria [38] was used for the clinical evaluation. The FDI criteria, which was 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, a score of 1 means that the quality of the restorations is excellent/fulfills all quality criteria, and the tooth or surrounding tissues are adequately protected.[38] Score 2 is selected when the quality of the 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 a score of 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.[39] There was no patient dropout 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, and 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). A 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 were not met. The level of all statistical associations was set at $p< 0.05$. Kappa Cohen's inter-examiner reliability score was 0.9

RESULTS

Thirty-five participants were recruited for 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 three 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 study, giving a 100.0% recall rate

Table 1: Socio-demographic characteristics of the study participants

Characteristics	freq(n=35)	No of restorations	Percentage
Age group (ye ars			
<20	03	09	8.6
20-30	20	60	57.1
31-40	07	21	20.0
41-50	04	12	11.4
>50	01	03	2.9
Sex			
Male	06	18	17.1
Female	29	87	82.9

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-thirds (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.

Table 2: Distribution of cavity types

	Class I	Class II	Total
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)
Gender			
Male	17 (94.4)	1 (5.6)	18 (100.0)
Female	71 (81.6)	16 (18.4)	87 (100.0)
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)
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)

P values expunged

Table 2 shows the distribution of cavity types. The majority of class II cavities were on molars, with 36 (45.0%) in the maxilla compared to 44 (55.0%) in the mandible. More,6 (40.0%) class II cavities on premolars were located in the maxilla.

Concerning gender and cavity types, the table shows that females recorded the majority, 71(81.6%) of class I and 16(18.4%) of class II, compared to males who had 17 (94.4%) of class II and 1 (5.6%) of class I.

The relationship between the distribution of the test materials used and the types of cavities restored showed that more class I cavities were restored. Mandibular molars were the most restored. Of the 35 teeth restored with Nanohybrid, 27(77.1%) were class II, while 8(22.9%) were class II1. Similarly, ormocer was used to restore the same proportion of cavities as for Nanohybrid, 27(77.1%) and 8(22.9%) for class I and class II, respectively. However, Microhybrid was used to fill 34(97.1%) class I restorations compared to 1(2.9%) class III filled with Microhybrid composite resins.

The majority, 74(84.1%) of the small-size cavities, were class II, while 14(15.9%) were class III. Of the medium size cavities, 14(82.4%) were class II while 3(17.6%) were class III(p-value 0.860)

Classification of cavities into small and medium was based on the size of cavities as measured buccolingually. This has been included in the method on lines 164-165

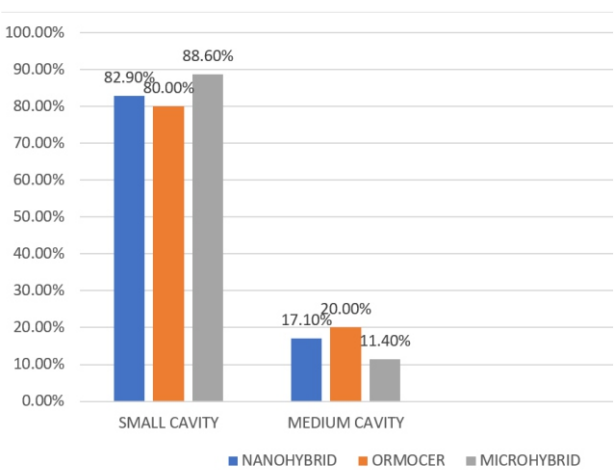

Fig 3: Distribution of test materials among cavity sizes

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.

Table 3: Functional Parameters of Nanohybrid

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 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						

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 patient's 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 a 100% score of 1 throughout the evaluation periods. The final functional score was 2, which is a 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
	1	35 (100.0)	35 (100.0)	35 (100.0)	34 (97.1)	34 (97.1)	0.448
FRACTURE &	2	-	-	-	1 (2.9)	1 (2.9)	
RETENTION OF	3	-	-	-	-	-	
MATERIAL	4	-	-	-	-	-	
	5	-	-	-	-	-	
MARGINAL	1	35(100.0)	35 (100.0)	35(100.0)	34 (97.1)	34(97.1)	0.448
ADAPTATION	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	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
ANATOMIC	2	-	-	-	2(5.7)	2 (5.7)	
CONTACT	3	-	-	-	-	-	
POINT	4	-	-	-	-	-	
	5	-	-	-	-	-	
RADIOGRAPHIC	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
EXAMINATION	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 a 100% score of 1 throughout the evaluation periods.

Table 5: Functional Parameters of Microhybrid

CRITERIA	SCORE	EVALUATION PERIODS					
		BASELINE n(%)	1MONTH n(%)	3MONTHS n(%)	6MONTHS n(%)	12MONTHS n(%)	P-VALUE
	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
FRACTURE &	2	-	-	-	2 (5.7)	2 (5.7)	
RETENTION OF	3	-	-	-	-	-	
MATERIAL	4	-	-	-	-	-	
	5	-	-	-	-	-	
MARGINAL	1	35 (100.0)	35 (100.0)	35 (100.0)	33 (94.3)	33 (94.3)	0.113
ADAPTATION	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	1	35 (100.0)	35 (100.0)	35 (100.0)	34 (94.3)	32 (91.4)	0.073
ANATOMIC	2	-	-	-	1 (2.9)	3 (8.6)	
CONTACT	3	-	-	-	-	-	
POINT	4	-	-	-	-	-	
	5	-	-	-	-	-	
RADIOGRAPHIC	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
EXAMINATION	2	-	-	-	-	-	
	3	-	-	-	-	-	
	4	-	-	-	-	-	
	5	-	-	-	-	-	
PATIENT'S	1	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	35 (100.0)	NA
VIEW	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 slight deterioration from 100.0% to 94.3% in the score of 1, with 2(5.7%) restorations scoring 2 for fracture of material and marginal integrity at 6 and 12 months. However, these changes were not statistically significant between baseline and 12 months of recall visits (p>0.05). The scores for wear, radiographic examination, and patient's 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

Experimental or randomized clinical trials are essential in assessing the clinical performance of restorative materials. These restorative materials get exposed to the variable conditions of the oral cavity. Therefore, clinical trials are preferred over laboratory tests.[40]

The present study evaluated the functional clinical performance of an ormocer (Admira voco) and light-cured nanohybrid (tetric Evoceram, Ivoclar Vivadent)) with microhybrid (tetric Ceram, Excite) acting as the control in carious posterior permanent teeth restorations in adult patients over 12 months. 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.[38]

The functional parameters of Nanohybrid restorations in the present study recorded a 100% score of 1 (clinically excellent) for the parameters; marginal adaptation, wear, radiographic examination, and patient's 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 that evaluated the clinical performance of Nanohybrid and Microhybrid using the FDI criteria,[39] 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. Other studies reported contrary findings.[39] In one study,[41] twenty-eight Nanohybrid restorations presented with good margins (score 2) while 8 had excellent margins (score 1) at 12 months. For the patient's view, there was a 100.0% score of 1 throughout the study. 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 randomized clinical trial to evaluate the clinical performance of a nanofill and a nanohybrid,[36] 85.4% of the Nanohybrid restorations evaluated at 12 months in that study 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 due to slow water hydrolysis. This is in contrast to the present study, which recorded a 100% score of 1 for the same parameter.

The clinical performance of the functional parameters of ormocer was evaluated over 12 months and was found to be clinically acceptable. Only one ormocer restoration 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 a slight reduction in the 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[29] 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 a 100% excellent score for fracture and retention of the restorative material at the end of the 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[42] that examined the clinical performance of ormocer reported excellent results regarding marginal adaption after 6 months. 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 study. In a study[39,43] that evaluated the clinical performance of microhybrid and nanohybrid, a score of 2 was assigned to 77.8% of microhybrid restorations compared to a score of 1 recorded by 22.2% restorations for the parameter marginal adaptation. This is contrary to the present study's finding, where the majority (94.3%) of the restorations were assigned a score of 1 for the functional parameter, marginal adaptation. Mahmoud et al.[29] reported a 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 more sensitive criteria, and despite the short evaluation period, one can conclude that ormocer (Admira voco) and 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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