CLINICAL EVALUATION OF RESIN COMPOSITE AND RESIN-MODIFIED GLASS IONOMER CEMENT IN NON-CARIOUS CERVICAL LESIONS

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Abstract

Background:

The clinical performance of various tooth-coloured materials used to restore Non-Carious Cervical Lesions (NCCLs) has been evaluated. However, most of these evaluations were in western societies where soft diets requiring little mastication were common. The present study sets out to evaluate resin composite and RMGIC in the restoration of NCCLs among a Nigerian subpopulation group with fibrous diet requiring more rigorous mastication.

Patients & Methods:

The study included all adult patients that presented at the Dental Hospital, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria with non-carious cervical lesions over a period of six months. The teeth with non-carious cervical lesions in each patient were allocated into

treatment with either resin composite or resin-modified glass ionomer cement by simple random sampling using ballots. The depth of the NCCLs was measured using a graduated flat ash periodontal probe. All the treatment was done by the first author according to the manufacturer's instructions. Patients were recalled and evaluated at 48- hours, 3- months, 6- months and 12- months using the USPHS criteria. Data analysis was done using SPSS version 15. The level of significance was put at 0.05.

Results:

At the end of 12 months, 143 resin composite and 144 RMGIC restorations were evaluated, out of which 37 resin composite and 13 RMGIC restorations were dislodged, giving a retention rate of 74.1% and 91.0% respectively. The difference was statistically significant ($p<0.05$). For marginal discolouration, marginal adaptation, abrasion wear resistance, post operative sensitivity, and secondary caries, there were no statistically significant differences in the performance of resin composite and RMGIC. There was more retention failure of both resin composite and RMGIC restorations in NCCLs in mandibular teeth than in maxillary teeth. The differences were statistically significant ($p<0.05$).

Conclusion:

RMGIC demonstrated a higher retention rate in the restoration of non-carious cervical lesions than resin composite over a period of 12 month.

Keywords: Non-carious cervical lesions, Restoration, Resin composite, RMGIC.

Introduction

Non-carious cervical lesions (NCCLs) are loss of tooth tissue at the neck of affected teeth that is unrelated to tooth decay[1]. Such lesions are a common finding in clinical practice. Erosion and abrasion have been widely reported as causes of non–carious cervical lesions[2,3]. However more recently, tooth flexure has been implicated in the formation of these lesions[4].

Results of several studies[5, 6] suggest that NCCLs do have multifactorial aetiology and that multiple causal mechanisms may operate in the initiation and progression of each individual lesion. Hence, the diagnosis of NCCLs into clinical entities such as erosion, abrasion, or abfraction is made difficult. However, such diagnosis may be important in determining appropriate management. Erosion has been defined as the progressive loss of hard dental tissues by a chemical process without bacteria action[7]. Smooth surfaces of anterior and premolar teeth are particularly vulnerable to attack by acids during the consumption of acidic foods and drinks which may cause erosion of tooth tissue[8]. Erosion lesions caused by acidic regurgitation tend to be found on the palatal surfaces of maxillary anterior teeth and occlusal surfaces of posterior teeth[9]. Abrasion is the abnormal wearing of tooth substance or structure by a mechanical process. Many factors such as improper or incorrect tooth brushing technique, excessive brushing force, bristle stiffness, brushing frequency and abrasivity of tooth paste are involved[3]. Abfraction introduced by Grippo[10] in 1992 is the disruption of the enamel crystal at the cervical region, secondary to tooth flexure, resulting from occlusal loading.

The diagnosis of NCCLs is basically from the clinical features, supported by the history of possible aetiological factors[7]. Factors that contribute to the diagnosis of stress-induced cervical lesions (abfraction) include the presence of occlusal wear facets, and wedge shaped lesions with sharp line angles[10,11]. Abrasion tends to be more obvious at the neck of teeth where it forms a rounded or V–shaped lesion, while erosion presents as U- or dish shaped, broad but shallow, smooth-edged depression[12].

The indications for treatment of NCCLs are dentine hypersensitivity, poor aesthetics, food stagnation, and likelihood of pulpal exposure[1]. The clinical performance of various tooth-coloured materials including conventional and resin-modified glass ionomer cements, polyacid-modified resin composites (compomers) and several types of composite resins used to restore NCCLs have been evaluated. However, most of these data were from western societies with soft diet requiring little mastication. Several studies[13, 14] strongly substantiate the theory that stress concentration at the

cervical region from occlusal loading is responsible for not only the development of cervical lesions, but, for restoration retention failure as well. Therefore the present study sets out to determine the clinical performance of resin composite and resin modified glass ionomer cement in the restoration of NCCLs among a Nigerian subpopulation group with fibrous diet requiring more rigorous mastication.

Patients and methods

The study included all adult patients that presented at the Oral Diagnosis and Conservative Units of the Dental Hospital, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria, with non-carious cervical lesions over a period of six months, from June 2007 to December 2007. Informed consent was obtained from the patients, and ethical clearance was given by the Ethical Committee of the Hospital. Patient's demographics were recorded.

The teeth with non-carious cervical lesions in each patient were allocated into treatment with either resin composite or resin-modified glass ionomer cement by simple random sampling using ballots. Inclusion criteria included: Patients presenting with a minimum of one pair of non-carious cervical lesions independent of their location in the dental arch. Teeth having cervical caries, fractures, pulpal involvement periapical pathology, mobility and restoration involving the buccal surfaces were excluded from the study.

The depth of the NCCLs were measured using a graduated flat ash periodontal probe from the greatest depth of the lesion to the estimated ideal buccal/labial contour compared to adjacent normal teeth according to Aw et al[15].

All treatment was done by the first author. The two experimental restorative materials (resin composite and resin-modified glass ionomer cement) were used on affected teeth in each patient so that the materials were subjected to the same oral conditions.

Clinical procedures for the restoration of NCCLs with resin composite: The tooth to be restored was cleansed with slurry of pumice and water. Shade selection of the resin composite restorative material was done under the clinic's natural lighting condition. The tooth was isolated with the use of rubber dam. Following the manufacturer's instructions, the tooth was acid-etched for 15 seconds with Henry Schein® 20/20 etching gel. This was followed by a thorough water rinse and careful air drying, leaving a white frosted appearance of a properly etched surface. Henry Schein® 20/20 Enamel and Dentine Universal bonding agent was then applied and evenly distributed on the etched surface with a gentle air stream. This was cured for 20 seconds with Dentsply visible light source (Dentsply QHL 75^{TM}). The chosen shade of resin composite material was placed using an incremental insertion technique (to reduce polymerization shrinkage) and each increment polymerized for 40 seconds with the visible light source. The composite restoration was then carefully polished using composite finishing burs, Ash white alpine stone and Vaseline® petroleum jelly (Chesabrough – Ponds Ltd Leeds LD 142 AR) coated rubber wheel.

Clinical procedures for the restoration of NCCLs with resin-modified glass ionomer cement: The tooth to be restored was cleansed with slurry of pumice and water. Shade selection of the composite restorative material was done under the clinic's natural lighting condition. The tooth was isolated with the use of rubber dam. Following the manufacturer's instructions, GC Dentine conditioner was applied for 20 seconds to the bonding surfaces using a cotton pellet. This was followed by a thorough water rinse and careful air drying, leaving a smooth (glistening) appearance of the tooth surface. The selected shade of resin-modified glass ionomer cement powder and liquid were dispensed on a paper pad and mixed with a plastic spatula according to the manufacturer's instructions. The cement was then transferred to the tooth surface with the aid of a suitable placement instrument. Air bubbles incorporation was avoided. Contour was formed and light cured for 20 seconds using a Dentsply visible light source (Dentsply QHL75^{TM}). For cavities deeper than 1.8mm, the material was placed in

layers. The restoration was then finished under water spray with tungsten carbide bur and polishing was done by using sof-lex polishing disc.

Clinical evaluation: Patients recalled and evaluated at 48- hours (baseline), 3- months, 6- months and 12- months using the United States Public Health Service (USPHS) criteria as described by Snyder and Ryge in 1987[16]. Each restoration was assessed at each visit by two clinicians familiar with the assessment procedure and criteria, independently. They later met to compare their independent assessment and area of disagreement(s) was resolved by consensus. United States Public Health Service criteria was used to evaluate retention, marginal adaptation, marginal discolouration, abrasive wear resistance, post operative sensitivity and secondary caries. The agreed score or outcome was recorded, along with the details relating to the patient, cavity and restorations.

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 15. The complete filling of the data collection instrument was ensured before entry into SPSS. The level of significance was put at 0.05.

Results

Between June and December 2007 a total of 44 patients (32 males, 12 females) presented with NCCLs. Their age ranges from 25-74 years with a mean age of 52 (SD ± 12) years. A total of 1,357 teeth were examined, out of which 338 (24.9%) had NCCLs and 1019 (75.1%) did not have NCCLs. Patients in the age group 50-59 years had the highest number of NCCLs 127 (37.6%) followed by age group ≤49 years 117 (34.6%) and age group ≥60 years 94 (28.2%). Table 2 shows the distribution of the NCCLs by jaw location, tooth type, and depth of lesion. More NCCLs were found in maxillary teeth (62.4%) than in mandibular teeth (37.6%). In the maxilla, more NCCLs were found in 1st premolars (16.6%) followed by canines (11.8%) and 2nd premolars (9.7%). While in the mandible, more NCCLs were found in the 1st premolars (16.0%) followed by the 2nd premolars

(9.2%) and canines (5.0%). One hundred and seventy eight (52.7%) of teeth with NCCLs were shallow (<2.0 mm deep) while 160 (47.3%) of the lesions were deep (≥2.0 mm).

Two of the resin composite restorations were dislodged at baseline. Of the 44 patients that were treated, 37 reported for 12 months recall visit, 7 patients (with 23 resin composite and 26 RMGIC restorations) were lost to follow-up. At the end of 12 months, 143 resin composite and 144 RMGIC restorations were evaluated, out of which 37 resin composite and 13 RMGIC restorations were dislodged (rated Charlie), giving a retention rate of 74.1% and 91.0% respectively. The difference was statistically significant ($p<0.05$) Table 3. For marginal discolouration, marginal adaptation, abrasion wear resistance, post operative sensitivity, and secondary caries, there were no appreciable differences in the performance of resin composite and RMGIC.

There were more retention failure for resin composite (26.1%) and RMGIC (13.0%) restorations in deep NCCLs compared to those in shallow NCCLs, (25.6%) and (5.3%) respectively at 12 month evaluation. The difference in retention failure for resin composite and RMGIC in deep NCCLs was not statistically significant ($p>0.05$). However, the difference in retention failure for resin composite and RMGIC in shallow NCCLs was statistically significant ($p<0.05$) as shown in Table 4.

Table 5 shows that there were more retention failure of both resin composite and RMGIC restorations in NCCLs in mandibular teeth when compared to maxillary teeth. The differences were statistically significant ($p<0.05$).

Discussion

In the present study 57% of the patients were 50 years and above. This agrees with earlier studies which found that the greater percentage of individuals having NCCLs belong to the middle aged and elderly population groups (50 years and above)[6, 15]. Older patients and their teeth have been exposed to the predisposing aetiologic factors for a much longer period than younger patients and their teeth[4,

[6]. In addition older patients are more likely to have gingival recession and alveolar bone loss, with more root surface and cementum exposure, thereby increasing the risk of NCCLs[17].

The maxillary teeth have higher frequency of cervical lesions than the mandibular teeth. This is consistent with the result of previous studies by Radentz et al.[18] Arowojolu[19] and Kitchin[20]. This may be due to the fact that most patients begin their tooth cleaning from the upper jaw with progressive decrease of force as the process continues. However, this is contrary to the findings of Sognnaes et al[21] in which the mandibular teeth were the most frequently affected teeth. The premolar especially the first premolar was the most affected tooth type in this study. This agrees with the result of previous studies[15, 18,]. This may be due to its prolonged contact with the toothbrush and/or chewing stick and its position in the arches which permit generation of maximum force in these areas. Radentz et al.[18] suggested that the presence of a bony anatomical deficiency on the facial prominence of the first premolar teeth may increase their susceptibility to gingival recession and abrasion. The absence of NCCLs in second and third molars in this study could be attributed to patients spending less time cleaning these teeth because of their inaccessibility in comparison with the premolars and also because some of the third molars may be partially erupted or impacted.

Contrary to the findings of other studies[22, 23], the failure rate of restorations in deep NCCLs in the present study was higher (26.1% for resin composite and 13.0% for RMGIC) than in shallow NCCLs (25.6% for resin composite and 5.3% for RMGIC). This may be due to the presence of sclerotic dentine in the deep lesions and such teeth would have required additional macromechanical retention before restoration. According to Yoshiyama et al.[24] the adhesive quality of the sclerotic dentine is inferior to that of the non-sclerotic dentine and this is because etched sclerotic dentine is more resistant to demineralization than is non-sclerotic dentine and therefore may make dentine less receptive to dentine bonding system.

In this study, the retention rate at the end of twelve months for RMGIC was 91.0% and resin composite was 74.1%. Thirteen restorations (9%) of RMGIC were dislodged while 37 (25.9%) of

resin composite restorations were dislodged. The difference between the retention rate of the two restorative materials at the end 12 months was statistically significant ($p<0.05$). The high retention rate for RMGIC can be attributed to better mechanical properties and better chemical bond to tooth tissue and also because RMGIC undergoes less stress and gap formation from thermal expansion and contraction[25]. Brackett et al.[26] comparing the clinical performance of RMGIC and resin composite restorations in NCCLS reported a retention rate of 96% for RMGIC and 81% for resin composite at 2 years, which is similar to the result of the present study though this study is of shorter duration. Frequently, the failure of these restorations has been linked to the stiffness of the restorative material. Yap and Neo[27] affirmed that the elastic modulus appears to be a significant property in retention of restorations used in NCCLs. When a more rigid material such as hybrid composite is used the shear stress at the adhesive interface could exceed the compressive stress, thus acting primarily on the dentine bond thereby resulting in restoration failure. Failure of retention may occur owing to cohesive or adhesive failure. Cohesive failure occurs because of a rupture within tooth structure or within restorative material. More typically, failure occurs at the weakest link, namely the tooth-resin interface[28].

In this study, there were more retention failure of both RMGIC and resin composite restorations in NCCLs in mandibular teeth when compared to maxillary teeth. This is in agreement with the findings of previous studies by Arowojolu[19] and Ziemecki et al.[22]. The increased failure rate is consistent with the lingual orientation of mandibular teeth which renders them more susceptible to the concentration of tensile stresses at the cervical regions[29]. The greater difficulty in moisture control in the mandibular teeth during restorative process[30], and fewer open tubules in mandibular dentine[31] may be possible contributory factors to the increased failure rate.

Conclusion

RMGIC demonstrated a higher retention rate in the restoration of NCCLs than resin composite over a period of 12 month.

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Table 1: The USPHS rating criteria

Category	Restorative Score	Criteria used in Rating Restoration
Retention	Alpha (A)	Restoration is fully intact
	Bravo (B)	Partial loss of restoration
	Charlie (C)	Total loss of restoration

Marginal discoloration	Alpha (A)	No discoloration anywhere on the margin between the restoration and the tooth margin.
	Bravo (B)	The discoloration has not penetrated in a pulpal direction along the margin.
	Charlie (C)	The discoloration has penetrated in a pulpal direction along the margin
Marginal adaptation	Alpha (A)	The restoration appears to adapt closely to the tooth along the periphery of the abrasive wear restoration. An explorer does not catch when drawn across the margin, or when it does catch, it will catch only in one direction and no crevice is visible.
	Bravo (B)	The explorer catches and there is visible evidence of a crevice into which the explorer will penetrate. However, neither dentine nor base is visible
	Charlie (C)	The explorer penetrates into a crevice that is of such depth that dentine or base is exposed
Abrasive wear resistance	Alpha (A)	Completely intact with no loss of contour
	Bravo (B)	Slight contour loss, replacement is unnecessary
	Charlie (C)	Extensive contour loss requiring replacement
Post operation sensitivity	Alpha (A)	Post operative sensitivity entirely absent
	Bravo (B)	Slight sensitivity to temperature change and / or probe exploration
	Charlie (C)	Severe sensitivity to temperature change and / or probe exploration
Secondary Caries	Alpha (A)	No Caries present
	Charlie (C)	Caries present

Table 2: Distribution of NCCLs by jaw location and depth of lesion

			Shallow		Deep	
Jaw location	no	(%)	no	(%)	no	(%)
Maxilla						
Central incisors	38	(11.2)	18	(5.3)	20	(5.9)
Lateral incisors	29	(8.6)	21	(6.2)	8	(2.4)
Canines	40	(11.8)	26	(7.7)	14	(4.1)
1st premolars	56	(16.6)	18	(5.3)	38	(11.2)

2nd premolars	33	(9.7)	14	(4.1)	19	(5.6)
1st molars	15	(4.5)	5	(1.5)	10	(3.0)
2nd molars	0	(0.0)	0	(0.0)	0	(0.0)
3rd molars	0	(0.0)	0	(0.0)	0	(0.0)
Total	211	(62.4)	102	(30.1)*	109	(32.2)
Mandible						
Central incisors	8	(2.4)	8	(2.4)	0	(0.0)
Lateral incisors	11	(3.3)	10	(3.0)	1	(0.3)
Canines	17	(5.0)	10	(3.0)	7	(2.1)
1st premolars	54	(16.0)	27	(7.9)	27	(7.9)
2nd premolars	32	(9.4)	20	(5.9)	12	(3.6)
1st molars	5	(1.5)	1	(0.3)	4	(1.2)
2nd molars	0	(0.0)	0	(0.0)	0	(0.0)
3rd molars	0	(0.0)	0	(0.0)	0	(0.0)
Total	127	(37.6)	76	(22.5)	51	(15.1)

*Rounded percentages

Table 3: Evaluation of resin composite and resin modified glass ionomer cement restorations in NCCLs

	Baseline					6 Months					12 Months				
		A	B	C	(A+B)%		A	B	C	(A+B)%		A	B	C	(A+B)%
Retention															
Composite	168	166	0	2	98.8	147	115	0	32	78.2	143	106	0	37	74.1
RMGIC	170	170	0	0	100.0	148	136	0	12	91.9	144	131	0	13	91.0
			Fisher exact p = 1.0					Fisher exact p = 0.001					Fisher exact p = 0.0002		
Marginal discoloration															
Composite	166	0	0	0	100.0	115	110	5	0	100.0	106	99	6	1	99.1
RMGIC	170	0	0	0	100.0	136	132	4	0	100.0	131	126	4	1	99.2
			Fisher exact p = 1.0					Fisher exact p = 0.74					Fisher exact p =		
0.67															
Marginal adaptation															
Composite	166	0	0	0	100.0	115	110	5	0	100.0	106	102	3	1	99.1
RMGIC	170	0	0	0	100.0	136	131	5	0	100.0	131	125	6	0	100.0
			Fisher exact p = 1.0					Fisher exact p = 1.0					Fisher exact p = 0.45		
Abrasive wear resistance															
Composite	166	0	0	0	100.0	115	115	0	0	100.0	106	103	3	0	100.0
RMGIC	170	0	0	0	100.0	136	136	0	0	100.0	131	129	2	0	100.0
			Fisher exact p = 1.0					Fisher exact p = 1.0					Fisher exact p =		
0.66															
Post operative sensitivity															
Composite	166	161	4	1	99.4	115	114	1	0	100.0	106	105	1	0	100.0
RMGIC	170	168	2	0	100.0	136	136	0	0	100.0	131	131	0	0	100.0
			Fisher exact p = 1.0					Fisher exact p = 0.46					Fisher exact p = 0.45		
Secondary caries															
Composite	166	0	0	0	100.0	86	86	0	0	100.0	72	72	0	0	100.0
RMGIC	170	0	0	0	100.0	154	154	0	0	100.0	117	117	0	0	100.0
			Fisher exact p = 1.0					Fisher exact p = 1.0					Fisher exact p = 1.0		

Table 4: Retention rate of resin composite and RMGIC restorations by depth of NCCLs

	Resin composite				RMGIC			
	Retained		Dislodged		Retained		Dislodged	
	No	(%)	No	(%)	No	(%)	No	(%)
6 months								
Shallow (<2.0 mm)	64	(79.0)	17	(21.0)	73	(93.6)	5	(6.4)
Deep (>2.0 mm)	51	(77.3)	15	(22.7)	63	(90.0)	7	(10.0)
Total	115		32		136		12	
12 months								
Shallow(<2.0 mm)	58	(74.4)	20	(25.6)	71	(94.7)	4	(5.3)
					Pearson's $\chi^2 = 11.92$, p=0.0005			
Deep (>2.0 mm)	48	(73.9)	17	(26.1)	60	(87.0)	9	(13.0)
					Pearson's $\chi^2 = 3.68$, p=0.055			
Total	106		37		131		13	

Table 5: Retention rate of resin composite and RMGIC restorations by jaw location

	Resin composite				RMGIC			
	Retained		Dislodged		Retained		Dislodged	
	No	(%)	No	(%)	No	(%)	No	(%)
6 months								
Maxilla	76	(85.4)	13	(14.6)	89	(94.7)	5	(5.3)
Mandible	39	(67.2)	19	(32.8)	47	(87.0)	7	(13.0)
Total	115		32		136		12	
12 months								
Maxilla	71	(81.6)	16	(18.4)	85	(94.4)	5	(5.6)

					Pearson's $\chi^2 = 6.97$, p=0.008			
Mandible	35	(62.5)	21	(37.5)	46	(85.2)	8	(14.8)
					Pearson's $\chi^2 = 7.29$, p=0.006			
Total	106		37		131		13	