Original Article

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Clinical Efficacy of Nano Filled Resin Modified Glass Ionomer Cements in The Treatment of Class-V Non-Carious Cervical Lesion

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ABSTRACT

Background and Aim: With the expectation of having better clinical outcome in the treatment of Class-V non-carious cervical lesions (NCCLs), nano filled resin modified glass ionomer cement (RMGIC) has been introduced in dentistry. This study aimed to evaluate the clinical performance of nano filled RMGIC in the management of class V NCCLs.

Materials and Methods: A randomized clinical trial carried out at the Department of Conservative Dentistry and Endodontics, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. The patients had at least two NCCLs (erosion, abrasion or abfraction) on the buccal surfaces with approximal depth of 1-1.5 mm. Total 50 samples were included. Nano filled resin modified glass ionomer restoration was assessed by visual inspection with mirror according to Modified Ryge's Criteria by means of retention, color matching, marginal integrity and surface texture. Patients were recalled after 3, 6, and 12 months for follow up observations. Friedman Test was adapted to check whether the changes over time were statistically significant ($p < 0.05$) or not.

Results: At 12 months follow up, the retention of 47(94%) nano filled RMGIC showed Alpha rating. Regarding color matching, nano filled RMGIC were more color stable observed. The marginal integrity of nano filled RMGIC was also better after six months interval. Furthermore, polished enamel surface texture was achieved in 45 (90%) nano filled RMGIC at 12 months observation. Friedman test revealed statistically significant differences in retention ($p = 0.029$), color matching ($p = 0.029$), and marginal integrity ($p < 0.001$) scores over the evaluation periods.

Conclusion: The outcomes of using nano filled RMGIC in the restoration of cervical defects of teeth, were very encouraging regarding both clinical and patient-centered parameters such as retention, surface finish, and marginal integrity. For better understanding of the material, long term follow-ups are necessary.

Keywords: cervical lesions, class V restoration, clinical trial, composite resin, non-carious lesions, glass ionomer cement, nano filled.

INTRODUCTION

Non-carious cervical lesions (NCCLs) like erosion, abrasion, and abfraction are difficult to restore. The loss of dental hard tissues typically occur at the cement-enamel junction or the neighboring one-third of the crown or root.[1] Conventional glass ionomer cement releases fluoride and forms chemical bonding to tooth structures but they are usually associated with poor

aesthetic, moisture sensitivity, less wear resistance and less color stability.[2] In 1990s, manufacturers improved these shortcomings by adding resins to glass ionomer cement to produce resin modified glass ionomer cements (RMGIC), though some of the problems still remain.[3] During the last decade, resin-based composite particularly flowable composite materials have been extensively used to repair non carious cervical lesion because of their resilience.[4] However, the failure of restoration in clinical study may be caused by from simple postoperative sensitivity to discoloration, marginal leakage, even from polymerization shrinkage. The clinical success has enhanced with time as the adhesive technology has progressed and supplementary properties, such as fluorides have been incorporated to the materials.[5] For that reason, a number of fluoride-containing materials for instance resin-modified glass ionomer have been fabricated.[6]

Nano ionomer is the most recent advancement in an extended history of glass ionomer technology. Nano-particulated ionomer is the first RMGIC with nano technology which combines the advantages of bonded nanofiller particles and resin modified light cure glass ionomer cement. Nanotechnology offers some incomparable services which glass ionomer restorative materials can't, such as improved polish, aesthetics, abrasion resistance, optical qualities, increased release of fluoride, strength and retention.[7] Hence the objective of this study was to evaluate the clinical achievements of nano filled resin modified glass ionomer cement in Class-V non-carious cervical tooth loss.

MATERIALS AND METHODS

It was a randomized clinical trial performed at the department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka, Bangladesh. The buccal surface of the tooth of the selected patients aged 30-50 years who had at least two NCCLs, each about 1-1.5 mm deep. Total 50 samples were included for applying nano filled resin modified glass ionomer (Ketac N100; 3M, ESPE, USA) and adhesive material (FI Bond II; Shofu Inc., Japan). Selected teeth were vital teeth with at least adjacent two Class-V non-carious cervical lesion with more or less same extension in the premolar region (size 1-1.5 mm), teeth with occlusion and inter proximal contact. To minimize confounding factors, patients with poor oral hygiene/ gingivitis/ periodontitis/ fractured teeth/ carious teeth/ discolored teeth/ bruxism/ severe malocclusion/ immunocompromised conditions affecting salivary flow or oral health were excluded.
During examination, detail on tooth mobility, sensitivity test (by tactile, compressed air, cold and heat), occlusion, position and type of defects were recorded. Two weeks prior to the application of restorations, each subject obtained oral prophylaxis. Restorations were performed following manufacturer's instructions, without administering any local anesthesia.

After cleaning the lesions with prophylaxis paste, rubber cup was used to remove the topped deposits before restoration. The area was isolated using cotton rolls, and saliva ejector was used to control moisture per operatively. Shade selection was done using a Vitapan classic shade guide (VITA Zahnfabrik H. Rauter GmbH & Co. KG, Germany). Gingival retraction cord was used to isolate subgingival lesions. During the application of nano filled RMGIC, the tooth surface was dried. Then, with applicator, primer was applied for 15 seconds, dried using air syringe for 10 seconds and light cured for another 10 seconds using a dental cordless dual-wavelength curing light (DiaDent Group International, South Korea) with sufficient intensity (> 400 mW/cm^2). After that, the required amount of material was mixed on the mixing pad for 20 seconds with spatula until a uniform color was achieved. The cement was transferred quickly into the lesion, shaped and contoured the material gradually by interproximal carver, Ward's carver, ball burnisher, which were wetted with Ketac N100 primer so that nano-ionomer restorative could be prevented from sticking to them. The material was light cured for 20 seconds, finished and polished immediately after curing in same sitting. Polishing was gradually done by polishing bar, black/ violet disc, green disc and finally pink disc.

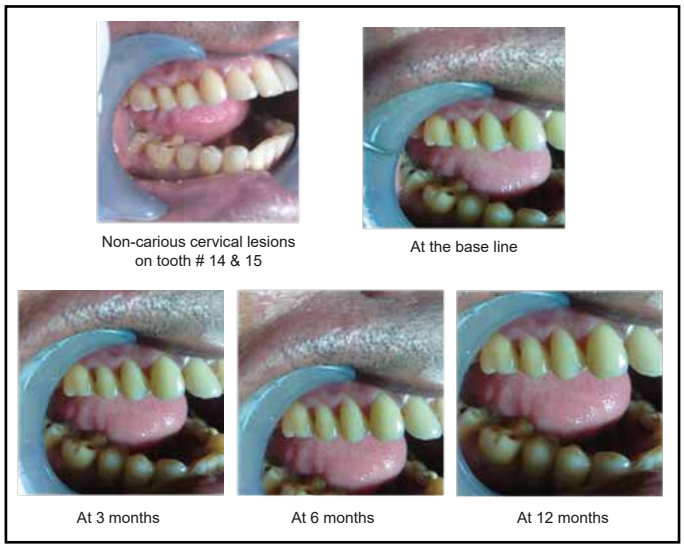

Fig. 1: Before and after treatment.

Patients received standardized post-operative instructions to maintain oral hygiene like- using soft tooth brush with brushing strokes from gums towards the tooth surface, avoid using highly abrasive tooth pastes, using dental floss at least once a day and avoid intake of excessive acidic or staining foods. To minimize variability, the similar instructions were unvaryingly given to all participants.

The patients were clinically evaluated after 3, 6 and 12 months, and scored as modified USPHS (United States Public Health Service) or Ryge's Criteria.[8] The relatable history, inspection findings and investigation reports of each study subject were

documented appropriately. Statistical analysis was done by SPSS (version 20) and the findings were presented as tables. Friedman Test was conducted to check whether the changes over time were statistically significant or not. P value <0.05 was considered as significant.

RESULTS

Table 1: Evaluation of different properties. (n=50)

Evaluation period	Score	Retention	Color matching	Marginal integrity	Surface texture
		n (%)	n (%)	n (%)	n (%)
Baseline	Alpha (A)	50 (100.0%)	50 (100.0%)	50 (100.0%)	50 (100.0%)
	Bravo (B)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Charlie (C)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
After 3 months	Alpha (A)	50 (100.0%)	50 (100.0%)	50 (100.0%)	50 (100.0%)
	Bravo (B)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Charlie (C)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
After 6 months	Alpha (A)	50 (100.0%)	47 (94.0%)	50 (100.0%)	50 (100.0%)
	Bravo (B)	0 (0.0%)	3 (6.0%)	0 (0.0%)	0 (0.0%)
	Charlie (C)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
After 12 months	Alpha (A)	44 (88.0%)	44 (88.0%)	41 (82.0%)	45 (90.0%)
	Bravo (B)	0 (0.0%)	3 (6.0%)	6 (12.0%)	2 (4.0%)
	Charlie (C)	3 (6.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Missing Cases	3 (6.0%)	3 (6.0%)	3 (6.0%)	3 (6.0%)
p value		0.029	0.029	0.000	0.112

The study started with 50 patients. They all were followed up after three and six months. Attrition in the respondents was 6.0% during the follow up at 12 months. Changes of different properties over time is presented in Table I. Regarding evaluation of retention, A =Restoration is fully intact, B =Restoration is partially intact, C =Restoration is completely missing. The material demonstrated excellent retention at 6 months, 100% of restorations remained fully intact (Alpha), and also over 12 months, with only minimal loss (6%) at the end. Retention decreased significantly (p =0.029) over time, particularly at 12 months.

Regarding evaluation of color matching, A =Matches the adjacent tooth in color shade and translucency, B =Light mismatches with adjacent teeth, C =Mismatches in color with adjacent teeth which is not acceptable. Slight discoloration developed over time, but most restorations (88.0%) still maintained good color harmony at 12 months. Minor but significant (p =0.029) deterioration in color matching was observed with time.

Regarding evaluation of marginal integrity, A =No visual evidence of a crevice, B =Visual evidence of a crevice, C =Explorer penetrate up to the dentino-enamel junction. Marginal integrity was perfect (100% Alpha) until 6 months. At 12 months, 82% maintained perfect margins, but 12% showed minor crevices (Bravo). A highly statistically significant change (p <0.001) in marginal integrity scores was observed over time.

Regarding evaluation of surface texture, A =Similar to polished enamel, B =Gritty or white or similar supramicron-sized particles, C =Surface pitting is sufficiently coarse. During second follow up, 100% of restorations retained a smooth surface texture (Alpha). During third follow up, the surface texture remained highly polished and enamel-like in the majority of cases (90.0%). No statistically significant change in surface texture scores was observed across the evaluation periods.

The present study evaluated only nano filled RMGIC restorations. So, the findings cannot be comprehensive to other RMGIC without comparative evaluation. Patients received no additional or special clinical intervention beyond routine postoperative care. And the postoperative care instruction was similar to every individual. Hence, the observed results were attributed primarily to the material properties and clinical performance of nano filled RMGIC under uniform oral hygiene conditions. The study aimed to evaluate material performance under routine clinical conditions. No orthodontic correction was performed for minor malocclusion during the follow-up period.

DISCUSSION

Several clinical trials recommend the usage of NCCLs with non-retentive cavity preparation as a clinical model for evaluating the efficacy of restorative materials. This model allows assessment of the adhesive performance of materials under clinical conditions.[9]

Furthermore, the clinical service of a restoration in class-V non-carious lesions were assessed by using modified USPHS or Ryge's Criteria[8], which has been extensively used for longstanding clinical assessment of restorations and also is regarded as reliable for comparing studies conducted at various points in time. However, the advancement of a material depends on its durability in the mouth, color stability, marginal integrity and surface texture. So, in this study, the clinical outcome of nano filled RMGIC were assessed by using modified Ryge's criteria at baseline, and 3, 6 and 12 months. It was found that all restorations initially exhibited satisfactory color matching, surface texture and marginal integrity, and remained clinically intact with the tooth tissue. However, these qualities gradually diminished over time.

Regarding retention, the nano filled RMGIC that showed Charlie rating (completely missing) at 12 months, were replaced and

discarded from the study. However, at 12 months 44 (88.0%) nano filled resin modified glass ionomer showed retention within the cavity. This result is similar as the study of Jyothi et al.[10] Enamel margin of non-carious cervical lesion, if beveled, provides increased bonding area and thus retention.[9] However, in the present study, no beveling was done which might be the possible reason for failure of the restoration. Such failure may also result from polymerization shrinkage, insufficient elastic modulus and cervical flexure stresses.[11] Moreover, the choice of adhesive system plays a crucial role, particularly in large cavities where stress levels are higher. It is suggested that better retention can be accomplished by using the restorative material in combination with optimized isolation, and adhesive protocol.[11] Recent clinical studies have shown that the primer used in nano-filled Ketac Nano 100 is acidic, helping to modify the surface and improve adhesion of the Ketac Nano 100 restorative to hard tissue. This self-adhesive property must be ascribed to combined micromechanical interlocking and chemical interaction which might be the better retention rate of nano filled. Hence, depending on the current and previous studies it can be commented that retention loss results from multifactorial etiology such as selection of patient, occlusal stress, location, shape of the lesions, presence of sclerotic dentin, and also on the characteristics of the materials applied.[12,13]

The results of nano filled restorations in regards to retention was statistically significant. Earlier study has indicated that nanoparticulated ionomer are RMGIC with nanotechnology, which adds the benefits of RMGIC with bonded nanofiller particles, while measured on nanoscale, in the range of 0.1 to 100 nanometers. This extensive variety of filler particle can affect strength, abrasion resistance, and optical properties. Today, the groundbreaking advancement of nanotechnology has become the most exciting area of science and technology.[14] Thus, a glass ionomer with enhanced polish, adhesion, and beauty is the consequence of these two technologies. Additionally, it has enhanced fluoride release, strength, abrasion resistance, and optical qualities. Moreover, while compared to other ionomers on the market, nano ionomer has scarcer surface gaps, cracks, and microporosities.[14] This might be the possible reason of higher success rate in the retention of nano filled restoration observed in the present study.

After 6 months, 94.0% of nano filled RMGIC and at 12 months, 88% of nano filled RMGIC were matched for color with the respective tooth structure in shade and translucency. Study conducted by S. Konde et al. also supported that a higher proportion of cases among the Fuji IX group showed mismatched restorations due to increased opacity, making those too light.[7] This opacity is possibly caused by the size of glass particles in Fuji IX powder, median particle diameter being 6.17 µm.[15] These particles are much larger than the wavelength of light which is 350–750 nm, causing them to scatter light and produce an opaque material. In contrast, Ketac Nano 100 has much smaller particles, ranging from 0.1 nm (nanofillers) to 100 nm (nanoclusters), which are much below the wavelength of light. Because of this, light directly passes the material, making it extremely translucent. Additionally, the nanoparticles scatter the blue light selectively, and the restoration gets an opalescent effect.[7]

Loss of marginal integrity is a key indicator of restoration failure and a common reason for its replacement depending on the degree of the gap, incidence of secondary caries, or symptoms.[16] In the present study, concerning marginal integrity, all restorations (100%) showed Alpha rating (explorer did not stuck at baseline and no sign of a crevice along the margin) at 3 months. However, at 12 months, it decreased to 87.2% for nano filled RMGIC. Chandra et al. opined that as Class-V cavities are located cervically, restoration becomes challenging to the clinician.[17] The gingival margin of the Class-V cavities is typically found in the dentin or cementum, whereas the coronal margin is found in the enamel. Although adhesive solutions have undergone numerous advancements, it is still less certain how well they would adapt and adhere to cementum and dentin. Loss of marginal adaptation may also result from the cyclic flexure of the teeth in these cervical regions and the polymerization shrinkage of the adhesive substance.[18] Another factor associated with marginal seal is depended on adhesion between restorative materials to tooth structure. The adhesion of RMGIC with tooth structure occur through chemical attachment to enamel and dentin as well as hybridizing.[19] Nano-ionomer binds to the tooth structure chemically. Over a TEM (Transmission Electron Microscopy) analysis, Coutinho et al. observed, when the restorations were prepared with manufacturer's primer, the close-fitting interface between dentin and the nano-ionomer shows no signs of dentin demineralization or formation of hybrid-layer.[20]

The surface of a restoration, being rough or smooth, and the material's capacity for finishing and polishing are largely determined by the size and conformation of the filler particles. When the surface texture of the restoration was verified, it was found that all restorations (100%) showed alpha rating (no difference of surface texture with enamel) at baseline and 3 months follow up evaluation period for nano filled RMGIC, at 6 months nano filled resin modified glass ionomer restoration and also at 12 months. Therefore, it was considered that nano filled RMGIC exhibited the superior surface texture. The results of present study are analogous to the study of Jyothi et al.[10] The differences may be due to the restorative material's variation in microstructure and a negligible particle size. It is said that particle size of nano filled RMGIC ranges from 20-40 micrometers and 0.1 to 100 nanometers.[7]

Limitations

The study was conducted at a single center with smaller sample size and for a very short period. All these might decline the generalizability of the findings.

CONCLUSION

Despite of limitations in the present study, clinical performance of nano filled resin modified glass ionomer, over a period of 12 months, was satisfactory in terms of retention, surface texture and marginal integrity in the management of NCCLs. Baseline quality persisted up to early follow-up periods, signifying admirable clinical outcomes. Majority of the restorations continued to maintain clinically adequate ratings at the end of 12 months. For the management of NCCLs, nano filled resin modified glass ionomer cement may be used. Further studies with larger sample in longitudinal studies are required to confirm the constancy of the findings of this collective approach in the management of these combined lesions.

RECOMMENDATION

Multicenter study with long term follow-up is necessary to better understand the efficacy of material.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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DATA AVAILABILITY STATEMENT

The data presented in this study are available on reasonable request from the corresponding author.

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