Article

Clinical Performance of Glass Ionomer in Class V Restorations: One-Year Follow-Up of Pilot Study

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Abstract—**This study's purpose is to evaluate the clinical performance of Class V restorations in non-carious cervical lesions (NCCL's) using conventional glass ionomer *Riva Self Cure (SDI)* materials in a teaching institute for one-year follow-up. Participants with Class V restorations were recruited from the e-clinical database and reviewed after one-year. Two independent calibrated examiners were assigned to the clinical assessment with high inter-examiner reliability (κ =0.82). Modified Ryge / USPHS criteria was used for direct evaluation of the clinical performance of restorations. The criteria assessed were anatomical form, the presence of secondary caries, retention, marginal adaptation, surface staining, soft tissue health and post-operative sensitivity. Class V restoration restored with glass ionomer showed 80.9% retention rate. Secondary caries, retention, surface staining and soft tissue health showed high scoring of A (clinically excellent restoration) (>90%). The highest acceptable restoration percentage (A- clinically excellent restoration + B-clinically acceptable) was surface staining while the lowest scoring categories was post-operative sensitivity. There was significant difference between gender and post-operative sensitivity (p<0.05). Spearman Correlation test showed that the gender was significantly correlated with post-operative sensitivity (r=0.48) while marginal adaptation was significantly associated with anatomical form (r=0.36) and secondary caries (r=0.39). In summary, after one-year follow, conventional glass ionomers are still clinically acceptable material to restore Class V and come with minimal complications.**
Clinical Significance: Class V restorations restored with conventional glass ionomer is still relevant as a material of choice to restore NCCL's despite the advancement of resin based materials.

Keywords— **Class V, Cervical lesions, glass ionomer, abrasion, restorative dentistry.**

I. INTRODUCTION

Non-carious cervical lesions (NCCLs) and carious cervical lesion are commonly found and one of the main reasons for the attendance of patients to a dental clinic [1]. The NCCLs are frequently caused by abfraction, erosion and/or abrasion, and the prevalence was reported to be high with increase age [2, 3]. A study reported that the prevalence ranging from 76% to 80% in middle and elderly population [4]. The carious cervical lesions are caused by inadequate tooth brushing techniques, poor oral hygiene or excessive intake of corrosive foods and drinks. A multifactorial etiology of cervical lesion has been reported. It may occur in a combination of factors that causes NCCLs and carious cervical lesion, which leads to further destruction to enamel and dentin tooth structures [5].

Class V restorations are common which were proved in a study that showed around 38% NCCLs occured in more than than 6,500 extracted human teeth [6]. Almost half of the maxillary teeth had NCCLs and approximately 36% was found in the mandibular teeth. Canines and first premolars are the commonest reported teeth with NCCLs. The clinical management of cervical lesion varies between clinician. Bader et al. [7] highlighted that the treatment for cervical lesion among dental practitioners includes; no active treatment, restoration of the lesions or restorations with occlusal modification. Restoration is required when such conditions exist. The lesions compromising the structural integrity of the tooth such as increase the likelihood of pulpal exposure, dentine hypersensitivity issue, unacceptable aesthetic or the tooth require modifications and adjustment prior to the provision of dental prostheses.

The restoration of the cervical lesion (also known as Class V restoration) is challenging because it does not offer a macro-mechanical form of retention [8]. Furthermore, the bonding has often compromised due to resin-dentin complex, which is less stable than within enamel complex. Thus, Class V restorations are susceptible to loss of retention. Proper isolation and restorative techniques are essential to ensure the adaptation and bonding of the tooth structure with the restoration materials, to prevent restoration failure and to ensure a successful restoration. In addition, the type of restorative material is also a major determinant for the success of the restoration. A number of restorative materials

are being used for Class V restorations, this includes conventional glass ionomer cement (GICs), resin-modified glass ionomer cement (RMGICs), polyacid-modified resin-based composite (compomers), a GIC/RMGIC liner base laminated with a resin composite [9]. There is no restorative material that is superior for cervical lesions. Studies have shown a variation of cervical lesion restorative materials recommended by different researchers and clinicians. [10, 11].

A systematic review of twenty-seven clinical trials concluded that glass ionomer cement has the lowest risk of loss of retention, which indicated highest success rate, compared to etch-and-rinse techniques [10]. Glass ionomer cement can adhere at dentine surfaces, as well as on sclerosed dentine [12]. Thus, the aim of this study was to evaluate the clinical performances of Class V restoration using conventional GIC materials performed by the undergraduate students. The hypothesis is the NCCLs restored by the undergraduate student with GIC showed a satisfactory result at one-year follow-up.

II. MATERIALS AND METHODS

A. Sampling

A descriptive retrospective study was conducted for this study. Participants were recruited from the e-clinical database with a total of 14 patients and 34 restorations overall. The selection was made based on the patient record who had Class V cervical lesions and had undergone treatment for it. Participants who had Class V restorations using conventional glass ionomer Riva Self Cure (SDI) were identified and scheduled for one-year follow-up. Prior to the appointment, verbal consent was obtained from the participant followed by a written consent before the intraoral assessment was performed. The inclusion criteria included were: Class V restoration performed by the final year undergraduate students, having good oral hygiene (was assessed using a plaque score index; < 20%), healthy gingiva with no sextants score 3 and 4 in the basic periodontal examination (BPE), the assessed tooth was vital, and have opposing natural dentition. The exclusion criteria were: presence of periodontal disease or oral pathology lesion, participants with deleterious oral habits such as bruxism and carious cervical lesion.

B. Clinical Evaluation

Two independent calibrated examiners were responsible for the clinical assessment. Inter-examiner data showed the kappa value of 0.82, which indicated high inter-examiner reliability. 'Modified Ryge/United States Public Health Service criteria' (Modified Ryge/USPHS criteria) was used for direct evaluation of clinical performance of the restorations [13]. The criteria assessed were: anatomical form, the presence of secondary caries, retention, marginal adaptation, surface staining, soft tissue health and post-operative sensitivity (Table I).

The restorations were assessed and rated accordingly by two examiners in different examination rooms. The restoration was considered as 'intact' if it was in place as recorded. The restoration was considered as 'failure' if it was not present or dislodged from the recorded tooth. The

restoration assessments were performed using standardized dental probes and dental mouth mirrors. The post-sensitivity was assessed using a blast of air from a triple syringe. The restorations were rated as; Alpha (A) - clinically excellent restoration, Bravo (B) - clinically acceptable, Charlie (C) – clinically unacceptable and Delta (D) - clinical failure that requires replacement or repair. The 'acceptable restoration' was Class V restorations that fulfilled Alpha (A) and Bravo (B) criteria. The percentage of 'acceptable restoration' was a summation of A and B percentages.

TABLE I
MODIFIED RYGE / USPHS CRITERIA RATING SYSTEM

Category	Rating	Characteristics
Anatomical form	A	Restoration's contour is continuous with existing anatomical form and margins
	B	Restoration is slightly over contoured or under contoured
	C	Marginal overhang or tooth structure (dentin or enamel) is exposed
	D	Restoration is missing, traumatic occlusion or restoration causes pain in tooth or adjacent tissue
Secondary Caries	A	No visible caries
	C	Caries contiguous with the margin of the restoration
Retention	A	Present
	B	Partial loss
	C	Absent
Marginal adaptation	A	Excellent continuity at cement-enamel interface, no ledge formation, no discoloration
	B	Slight discoloration at cement-enamel interface; ledge at interface.
	C	Moderate discoloration at cement – enamel interface measuring 1mm or greater
	D	Recurrent decay at margin
Surface staining	A	Absent
	C	Present
Soft tissue health	A	Excellent response, no inflammation
	B	Slight inflammation of gingival tissue
	C	Moderate to severe gingival inflammation
Post-op sensitivity		Yes/No

III. RESULTS AND DISCUSSION

A. Statistical Analyses

Data were recorded, and analyses were performed using IBM SPSS 23.0. Descriptive analyses were used to present the prevalence of restoration characteristics for clinical modified USPHS evaluation rating system. These included: anatomical form, secondary caries, retention, marginal adaptation, surface staining, soft tissue health and post-operative sensitivity. Chi-square analyses were performed to evaluate the association of gender and age with the restoration characteristics: anatomical form, secondary caries, retention, marginal adaptation, surface staining, soft tissue health and post-operative sensitivity. Spearman correlation was performed to determine the intercorrelation between the variables. The level of significance was set at p<0.05 for all analyses.

The mean age of the participants was 54.8 years old (SD 12.7). A high percentage of participants (85.3%) were aged between 51 to 70 years old. Approximately 57% of the participants were male and 43% were female. 71.5% were Malay, 21.4% were Chinese and 7.1% were Indian participants. Six of the participants had more than two Class V restorations, with three of them had six Class V restorations each. A total of 42 Class V lesions had been restored with conventional GIC restorations at baseline and was follow-up at one-year. More than half of the restorations (n=34) were intact and were evaluated using the Modified Ryge/USPHS Guidelines System. Eight restorations were totally dislodged at one-year follow-up with retention rates up to 80.9%.

Table II presents the prevalence of clinical evaluation in each category. Less than half of the restorations were categorized as 'excellent restoration (A)' at one-year follow-up in terms of 'anatomical form'. A high percentage (>90%) of the restorations was categorized as 'excellent restoration (A)' in terms of secondary caries, retention, surface staining, soft tissue health and post-operative sensitivity.

TABLE II

CLINICAL EVALUATION OF CONVENTIONAL GLASS IONOMER RESTORATIVE SYSTEM

CATEGORY	A% (n)	B% (n)	C% (n)	A% + B% (n)
Anatomical Form	35.3% (12)	61.8% (21)	2.9% (1)	97.1% (33)
Secondary Caries	94.1% (32)	–	5.9% (2)	94.1% (32)
Retention	97.1% (33)	2.9% (1)	–	100% (34)
Marginal Adaptation	64.7% (22)	26.5% (9)	8.8% (3)	91.2% (31)
Surface Staining	100% (34)	–	–	100% (34)
Soft tissue Health	97.1% (33)	2.9% (1)	–	100% (34)
	Absent	Present	-	-
Post-operative Sensitivity	85.3% (29)	14.7% (5)	-	-

Half of Class V restorations were present on the lower arch (50.1%). Lower premolar has the highest prevalence of cervical lesion (35.7%) followed by the upper premolar (23.9%), upper anterior teeth (19.0%) and lower anterior teeth (14.4%). Chi-square tests as in Table III were performed and there was a significant difference between gender and post-operative sensitivity (p=0.011). There was no significant difference between gender with other variables: anatomical form, secondary caries, retention, marginal adaptation, surface staining and soft tissue health (p>0.05). There was no significant difference between the subjects age and USPHS criteria (p>0.05).

The findings from Spearman's Correlation was presented in Table IV. Gender was significantly correlated with post-operative sensitivity (r=-0.47). 'Secondary caries' was significantly correlated with 'marginal adaptation' (r=0.39) and 'anatomical form' was significantly associated with 'marginal adaptation' (r=0.36) and 'retention' (r=0.34).

TABLE III

ASSOCIATION BETWEEN GENDER AND THE CRITERIA

Factor	Gender		p-value
	Female (%)	Male (%)	
Anatomical Form			
Follow anatomical form and margins	7 (58.3%)	5 (41.7%)	0.832
Not follow anatomical form and margins	12 (54.4%)	10 (45.5%)	
Secondary caries			
No caries	18 (56.3%)	14 (43.7%)	0.695
Carious	1 (50.0%)	1 (50.0%)	
Retention			
Present	18 (54.5%)	15 (45.5%)	0.559
Partial loss or absent	1 (100.0%)	0 (0.0%)	
Marginal adaptation			
Excellent adaptation	14 (63.6%)	8 (36.4%)	0.218
Slight or moderate adaptation	5 (41.7%)	7 (58.3%)	
Surface staining			
Absent	19 (55.9%)	15 (44.1%)	NA
Present	-	-	
Soft tissue health			
No inflammation	18 (54.5%)	15 (45.5%)	0.559
Inflammation	1 (100.0%)	0 (00.0%)	
Post-op sensitivity			
Yes	0 (00.0%)	5 (100.0%)	0.011*
No	19 (65.5%)	10 (34.5%)	

r values obtained from Chi-square Test.
*p<0.05

	Secondary Caries	Retention	Soft tissue Health	Post-operative Sensitivity	Marginal Adaptation	Anatomical Form
Gender	-0.03	0.155	0.155	-0.467**	-0.172	0.00
Secondary Caries		-0.044	-0.044	-0.104	0.393*	-0.083
Retention			-0.03	-0.072	0.316	0.345*
Soft Tissue Health				-0.072	-0.126	0.115
Post-operative sensitivity					0.166	0.274
Marginal Adaptation						0.359*
Anatomical Form						

r values obtained from Spearman's Correlation Coefficient values.
$*p<0.05$, $**p<0.01$, $*** p <0.001$

B. Discussion

The present study evaluated Class V restored with conventional glass ionomer by the final year undergraduate dental students. The recall appointment was done after one-year the cavities had been restored due to the study was aimed to assess the quality of Class V restoration done by undergraduate USIM dental students in a short-term re-evaluation. It was measured using Modified Ryge/USPHS Guidelines System, first introduced by Cvar and Ryge in 1971 [13]. Modified Ryge/USPHS Guidelines System was one of the most common guidelines used to evaluate the performance of dental restorative material [14]. The cervical lesions were more prevalent on premolars teeth and the facial aspect of the tooth and these findings was concurrent with other studies [3]. Cervical lesions were found to be associated with increased age and the prevalence was higher (>80%) in subjects whose age was more than 50 years old [3, 4, 15]. Younger person does not show a significant association with the prevalence of NCCLs [16]. This cannot be proved in the study due to limited sample size and most of the participants were aged 50 years and below.

By and large, other dental materials such as resin modified glass ionomer cement (RMGIC) maintain an advantage over glass ionomer in terms of physical strength, better aesthetics properties and good bonding due to resin properties and characteristics within the material. It is also agreed that resin-based materials can be considered as a standard material towards restoring the cervical lesions [17]. However, mixed reviews and opinions were also reported regarding marginal adaptation, wearability and aesthetic issue [18, 19]. Other clinical properties such as low wear resistance and loss of anatomical form were obvious in long-term review for RMGIC [20]. This study showed that the restoration of cervical lesions with conventional glass ionomer remain relevant with high percentage of clinically acceptable restorations in each category after one-year follow up. A systematic review by Santos et al showed that conventional glass ionomer cement has a significant low loss of restoration for non-carious cervical lesion compared to multiple different adhesive systems materials [21]. Therefore, it can be justified to use glass ionomer especially on posterior teeth in which the aesthetic properties are less of concerns. Glass ionomer cements also maintain advantages to other resin-based materials such as less technique sensitive, absence of resin particle that will eliminate the potential problem such as polymerization shrinkage and no specific adhesive and bonding protocols that will indirectly reduce the overall clinical time.

After one year, the retention rate criteria scored for the conventional glass ionomer was considerably high (80.9%) despite the restorations had been placed by the undergraduate students and its comparable to the retention rates of resin composite restoration which were between 76.9% to 90.6% [19]. The retention rates of conventional glass ionomer are generally considered good and high for short-term and long-term [19, 22]. A recent clinical trial showed that glass ionomer restoration has high and superior retention rates compared to the other alternative restoration materials such as giomer [23].

In this study, we found a significant correlation between marginal adaptation and secondary caries. Microleakage is one of the main factors that can contribute to the secondary caries formation in any restorations due to the loss of the integrity of the marginal seal. Physical properties of a restoration such as water sorption and polymerisation shrinkage have been reported to significantly affect the marginal seal [24]. However, a narrow gap or a small microleakage area does not necessarily lead to the formation of secondary caries [25, 26]. The movement of the particles particularly bacteria, ionic exchange and saliva in between the cavity preparation surface and restorative material, especially in Class V cavity will further alleviate the problem [27]. This potential problem will not arise with glass ionomer since the absence of resin material will eliminate the potential polymerization shrinkage and improve the retention rate, post-operative sensitivity and marginal adaptation. Glass ionomer is a fluoride reservoir and fluoride releasing material, thus it can prevent caries lesion as compared to the resin composite restoration [28, 29].

In addition, there were significant correlation between anatomical form with retention and marginal adaptation. More than half of the restorations were over-contoured or under-contoured with less than half of the restoration was found to have an under-contoured with existing anatomical form and margins. Low wear resistance of the restorative materials from repeating the process of masticatory complex cause loss of anatomical form and affects the longevity of direct restoration. Glass ionomer restorations can be further deteriorated and abraded with the use of medium or hard toothbrush, patients with gastric reflex, bruxism or heartburn, individuals who consume citrus fruits, alcohol or soft drinks frequently and those who have group function or clicking joints [30]. The present study showed that the marginal adaptation was moderately acceptable with only above half of the restorations had excellent continuity at the resin-enamel interface. Marginal adaptation remains as a main

issue in many types of restorative dental materials biomechanical complication [31-33].

Generally, all the patients attended the faculty dental clinic are required to undergo Basic Periodontal Health (BPE) screening. The recruited participants were those who had a healthy gingiva condition with no sign of any periodontal diseases and good oral hygiene. As a result, the soft tissue health criteria scored was high even after one-year follow-up. Moreover, there were no overhanging restorations or supragingival margin placement of restoration were observed in the study. Absent of these conditions were essential to ensure that the periodontal tissue surrounding the restoration are healthy [34]. Crown lengthening, orthodontic extrusion or using a photocured gingival barrier or a mylar strip were recommended techniques for good cervical contour. Subgingival placement of restoration also can be modified preoperatively by crown lengthening surgery or orthodontic extrusion [8, 34].

Despite the limitation of this study, the overall clinical performance of glass ionomer in restoring Class V cervical lesions remains acceptable. Besides, the restorations in this study were performed by the undergraduate students with no failure were reported based on 'Delta (D) – a clinical failure that requires replacement or repair' criteria of Modified USPHS. 'Clinically acceptable' restoration was also observed to be in a high range. Thus, the Class V restorations performed by the undergraduate students were comparable to experience clinician at one-year follow-up.

IV. CONCLUSIONS

Restoration of cervical lesions with conventional glass ionomer cement remains relevant and proved to be very predictable and successful results. In this pilot study it was proven that after one-year follow, conventional GIC are still clinically acceptable to restore Class V and come with minimal complications despite the advancement and recommendation for other materials such as RMGIC, compomer and resin composites. Nevertheless, a clinical trial comparing restorative materials are desirable to decide the best materials to restore NCCL's.

TABLE V

GLASS IONIMER CEMENT USED IN THIS PROJECT

Material	Riva self cure/ Riva self cure HV (SDI)
Composition	Acrylic acid polymer, tartaric acid and fluoro aluminosilicate glass
Method of Application	Direct Restoration

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