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Knowledge on Benefits of Glass Ionomer Cement (GIC) over Silver Amalgam Restoration in Pediatric Patients Among Dental Students- A Survey

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Abstract:

Background of the study: Tooth coloured restoration has been widely preferred for aesthetic reasons particularly in paediatric population despite several disadvantages than conventional restorative material. With development of various tooth coloured cements and resins as an amalgam alternative created a dilemma among students towards choice of material and its reliability in dental practice.

Aim: The present questionnaire study was aimed to assess the knowledge on practice of Silver amalgam and Glass Ionomer Cement as restorative materials and its relative clinical advantages in pediatric dentistry among dental students across Tamilnadu.

Materials and Methods: An online cross-sectional questionnaire survey was conducted among dental college students across Tamilnadu using Google forms distributed through various social media platforms. The scores were evaluated based on responses, and relevant statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) statistics Version 24.0.

Results: Majority of the participants responded GIC as the choice of restorative material in children ($p<.0001$) among which 71.83% believes it is comparatively durable ($p<.0001$), and 84.51% accepts silver amalgam is not advised for paediatric patient owing to its mercuric toxicity, delayed expansion and galvanic corrosion. The association between choice of GIC over dental amalgam and the year of study among dental students was statistically insignificant.

Conclusion: The present study clearly showed adequate knowledge awareness on characteristic of GIC over silver amalgam despite significant use of amalgam in routine dental practice largely influenced by specified dental (BDS/MDS) curriculum and institutional practice. Further efforts are needed among dental students and professionals to educate their patients who prefer amalgam restoration over tooth coloured materials by imparting clear understanding of distinctive features, strengths, and weaknesses of each material based on the clinical condition rather than on choice of their own by personal influences.

Keywords: Attitude, Biocompatibility, Fluoridated amalgam, Glass Ionomer cement, Mercuric toxicity, Restorative material.

Introduction:

Tooth coloured restoration has been widely preferred over the years for aesthetic reasons particularly in paediatric population owing to its substantial role in imparting well-being psychic state of the child, promoting growth by healthy restoration and/or rehabilitation of primary and mixed dentition, and facilitate permanent teeth development [1,2]. The American Academy of Paediatric Dentistry (AAPD) previously established the usage of amalgam, and stainless-steel crowns for posteriors while silicate cement, and aesthetically acceptable acrylics were recommended for anterior region. However with advancement of various tooth coloured cements and resins over the years, AAPD currently proposed that material selection and adequacy varies for each restorative situation [2-4].

Amalgam is one of the excellent restorative material with low cost, high strength and durability, ease of application, long-time clinical stability and superior longevity than any other material available. However mercuric toxicity, poor aesthetics (anterior), discolouration, marginal leakage, bulk restorative material fracture, tooth fracture, higher caries recurrence, and complex cavity design limited its use despite phase modified amalgam, fluoridated amalgam, bonded amalgam, and replacing mercury in amalgam with Gallium, Indium or Platinum were practiced [5-7]. In order to overcome these disadvantages, glass Ionomers (GI) were first introduced by Wilson and Kent (1970) in dentistry with enhanced strength, rigidity, adhesiveness, and biocompatibility alongside fluoride release property [8].

Glass Ionomer cements (GIC) are capable of forming chemical linkage between carboxylate groups and calcium ion (ionic bonds) present in enamel and dentin, possess coefficient of thermal expansion similar to that of tooth structures, releases fluoride gradually over a period of time as well as promote

adequate biological response. With improvement in techniques and technologies several forms of GIC such as Resin-modified GIC (RMGIC), Light cured (LC-GIC), and Silver (metal) reinforced GIC cements were also introduced in routine paediatric dentistry [8, 9]. Studies by Mathur S [3], Pinto GDS [5], Lohbaeur U [8], Yengopal V [9], Atieh M [10], Al-Naimi OT et al [11] and Chadwick BL et al [12] also stated that modified GIC provides excellent retention and rapid setting thus making it convenient with ease of manipulation and placement in less cooperative, and low compliance patients like children.

Over the years, the development of various tooth coloured cements and resins served as an alternative material of choice and have reduced the use of amalgam in dental practice. Owing to availability of number of tooth coloured restorative materials, the appropriate case selection and choice of restoration with distinguished paediatric use in addition to amalgam, stainless steel crowns, composite resins and compomers is always a challenging task [13]. Irrespective of several disadvantages and limitations, studies by Bharti R [14], Lins SA [15], Khangura SD [16], and Al-Nahedh HN et al [17] still continue to support amalgam as a safe restorative material of choice for both adult and paediatric population despite decline in use of amalgam has been reported in studies by Dixit PB et al [7], Bernardo M et al [18], Rathore M [19], Mitchell RJ et al [20], Aggarwal VR et al [21], Khan SA et al [22], and Patil SN et al [23].

On the other hand, Studies by Togoo R et al [2], Madhavan S [4], Nayab T et al [6], Vidnes-Kopperud S [24] and Balasubramani K et al [25] showed varying preferences of restorative materials including amalgam, GIC and composites among dental practitioners and dental students specifically in paediatric population thus creating a dilemma in choice of restorative material for primary teeth. It was also illustrated that majority of the dental students and practitioners felt amalgam use should be excluded and discontinued due to environmental and health concerns caused by mercury toxicity, yet this argument still remains controversial. Nonetheless, there is paucity of studies regarding dental undergraduates and postgraduates' perception towards GIC over dental amalgam as a restorative material in Tamilnadu, India. Thus the present study was aimed to assess the knowledge on practice of Silver amalgam and Glass Ionomer Cement as restorative materials and its relative clinical advantages in pediatric dentistry among dental students across Tamilnadu.

Methodology:

An online cross-sectional questionnaire-based assessment survey was carried out amongst the dental students across Tamilnadu to assess their knowledge on Silver amalgam and Glass Ionomer Cement as restorative materials and its clinical advantages in pediatric dentistry. After obtaining the Ethical clearance, 11 questions pertaining to the present study based on the previous literature were carefully chosen. The self-administered questionnaire was distributed among undergraduate and postgraduate dental students with selected answers to specific questions and category-wise responses (Yes/ No/ don't know) to few questions. Since this study was carried out during the COVID-19 Pandemic situation, online Google forms were generated and circulated through various social media platforms.

Statistical Analysis:

Non-probability random sampling method yielded information from 142 dental students across Tamilnadu were taken into this observational study with a cross sectional design. Responses recorded were evaluated using SPSS (Statistical Package for the Social Sciences V24.0 Illinois, Chicago) software Version 24.0. The internal consistency of the questionnaire was adequate (Cronbach's alpha = 0.833). All the study participants were briefed about the purpose of the study and a pre-filled online consent (Yes, I Agree) was obtained before the survey through Google forms and guaranteed that their participation was purely voluntary.

Results:

On analysis of the given data the mean age of the study population was observed as 22.49 ± 1.84 years (mean ± S.D) with 0.3052 at a 95% confidence level comprising 37 (26%) male and 105 (74%) female participants categorized as II-III year undergraduate dental students (20.4%), IV year undergraduate dental students (18.3%), CRRIs (54.9%) and postgraduate dental students (6.3%) respectively.

Majority of the participants responded GIC as the choice of restorative material in children ($p<.0001$) among which 71.83% believes it is comparatively durable ($p<.0001$), and 84.51% accepts silver amalgam is not advised for paediatric patient owing to its mercuric toxicity, delayed expansion and galvanic corrosion. 83.80% consider amalgam tattoo as a mucosal reaction caused by amalgam and 89.44% believes hazards of mercury in amalgam causing several local responses can be resolved by replacing mercury with using Gallium, Indium or Platinum ($p<.0001$).

No significant differences were observed among the study participant responses on GIC necessitating minimal tooth preparation with less complex cavity structure (93.66%) ($p=.0549$), characteristic free fluoride ion release (92.96%) ($p=.0645$), cariostatic effect (81.69%) ($p=.0742$) and also lack of significant tissue/oral mucosal reaction (85.92%) ($p=.93103$) thus contributing to the superiority and high biocompatible (95.07%) ($p=.31499$) nature of GIC over silver amalgam (Table 1).

Discussion:

Aesthetic restorative materials such as GIC, Resin ionomers, Resin-based composites and improved systems like compomers have shown profound impact on the restoration of primary teeth, particularly in management of proximal and anterior caries compared to conventional treatment modalities using amalgam, stainless steel crowns, silicates cements or acrylics in paediatric dentistry. Hence a brief understanding of various advantages, and disadvantages

of these restorative materials for each clinical condition plays a significant role in treatment of paediatric patients. The present study clearly showed adequate knowledge awareness on superiority, biocompatibility, fluoride free ion release, anti-cariogenic effect, minimal tooth preparation with effective preservation of natural tooth surface, reduced prevalence of secondary caries and tissue reaction characteristic of GIC over silver amalgam.

The association between choice of GIC over dental amalgam and the year of study among dental students was statistically not significant. These satisfactory results could be attributed to sufficient information provided to dental students both at undergraduate and post graduate level through dental curriculum, research publications, integration of more continuing dental education programs, and clinical behaviour patterns in dental institutions towards use of GIC in paediatric population.

Majority of the participants (99%) responded GIC as the choice of restorative material in children. Similar results were observed by Togoo R et al [2], Madhavan S et al [4], Pinto GDS et al [5], Dixit PB et al [7], Balasubramani K et al [25], and Wuollet E et al [26] where more than half of dental students and practitioners prefer GIC for primary teeth while Bharti R [14], Rathore M et al [19], Gopalasamy K [27], Bellinger DC et al [28], Martin MD et al[29] and Osborne JW et al [30] revealed contrasting results among adult population. The difference in these observation are related with several factors like disparity in study population, pre-existing attitude, child's age, co-operative ability, extension of caries, caries risk, clinical condition, characteristics of the restorative material that includes fluoride release, longevity, strength, aesthetics, patients affordability and clinician's choice of material for paediatric patients. Thus, undergraduate and postgraduate dental students must educate their patients who prefer amalgam restoration over tooth coloured materials and should make them participate in an informed consent process before the placement of amalgam as well as during removal of the old amalgam restoration.

In the present study about 84.51% accepts silver amalgam is not advised for paediatric patient owing to its mercuric toxicity and 89.44% believes hazards of mercury in amalgam causing several local responses can be resolved by replacing mercury with using Gallium, Indium or Platinum. Studies by Nayab T et al [6], Dixit PB et al [7], Rathore M et al [19], Patil SN et al [23], Gopalasamy K [27], and Bellinger DC et al [28] revealed significant use of amalgam in routine dental practice despite adequate awareness regarding the mercury toxicity, possible environmental effects caused by improperly manipulated residues, mercuric vapours and also toxic concerns associated with development immaturity among children. It is significant that undergraduate and postgraduate students frequently uses amalgam in their institutional practice because of the specified quota to be fulfilled in their dental (BDS/MDS) curriculum.

Till now, except in individuals allergic to components of amalgam, several renal and neuropsychological effects observation study in children by Bellinger et al [28], Woods JS et al [31], Barregard L et al [32] and DeRouen TA et al [33] indicated clear lack of significant associations between amalgam exposure and clinical neuropsychological or renal signs observed. Thus revealing the lacunae and need for further scientific evidence, case control or in-vivo studies to establish a standard therapeutic rationale for mercury level with extensive amalgam restorations in a patient's mouth at which any toxic changes occur and for removing clinically adequate amalgam restorations.

About 95.07% agrees GIC possess higher biocompatibility than silver amalgam. Studies by Francisconi LF et al [1], Mathur S [3], Madhav S [4], and Bapat RA et al [34] showed GIC was the material of choice for deep caries without pulp exposure in primary teeth of children. Balasubramani K et al [25], Kovarik RE et al [35], and Nicholson JW et al [36] also described higher biological response with better chemical adhesion through ionic bonds (ion-binding potential) to the hydroxyapatite mineralized tissue such as enamel and dentin whereas biocompatibility of amalgam is often correlated to the mercuric toxicity and its effects. However further In-vivo/In-vitro studies, and clinical trials on efficacy, safety, and mechanism of action of amalgam substitutes by replacing mercury with Gallium, Indium or Platinum at varying concentrations with perceived outcomes are required to validate these observations.

In this study, 71.83% believes GIC is comparatively durable with silver amalgam. Lohbaeur U [8] , Zhao J et al [37] and Shabanian M and Richard LC [38] in an experimental study revealed improvement in strength level over a period of time in GIC due to water sorption and neutralizing the fatigue degradation even after one month following cyclic fatigue loading conditions despite the wear rates are standardized comparative to silver amalgam. Studies have also demonstrated adhesion to the tooth structure by replacement of hydroxyapatite structure plays a significant role. Although the exact mechanism is still unknown, Study by Francisconi LF et al [1] and Pascotto and Navarro [39] assumed that passage of the pulpal fluid through an absorption layer by the cements formed near the dentinal tubules compensate for the polymerization shrinkage and maintain the restorative marginal seal contributing to the overall durability of GIC.

In contrast, low copper amalgams had a comparatively shorter life span due to corrosion caused by gamma 2 phase (Tin- Mercury, Sn_8Hg phase) particularly at the tooth-amalgam interface. However, recent studies have proved that use of high copper amalgam, incorporating zinc with copper to improve resistance to corrosion have shown increased longevity and durability. In order overcome the microleakage, a coating of resin was used over amalgam restoration. But this was also not as effective as anticipated because the resin would wear away over time though it delayed the microleakage. Forss H [40], Köhler B et al [41] , Frankenberger R et al [42], and Burke et al [43] in their respective studies determined the overall average annual failure rates caused by fatigue fractures as 0–7% for amalgam comparatively lower than 1.9–14.4% observed for GIC. Hence an appropriate treatment plan should be formulated with increased usage of modified amalgam as a viable option in children with higher caries restorative demands.

No significant differences were observed among the study participant responses on GIC requiring minimal tooth preparation with less complex cavity structure. This can be explained by evidences demonstrating that GIC require less retention form which plays an important role of conserving the relatively thin enamel and dentin in primary teeth thus subsequently preventing caries invasion into the dentin and underlying young pulpal tissue that are proportionately larger and closer to the surface than permanent teeth. On the other hand, amalgam requires extensive tooth preparation which is not feasible as in case of primary teeth where mesiodistal width is more than cervico-occlusal width, clinical crown heights are shorter with broad and flat contact areas rather than being a small distinct circular contact point, as in permanent teeth. Bonded amalgams were introduce to preserve sound tooth structure and avoid mechanical retention that requires proper cavity design and extensive preparation. It should be emphasized that the success of restoration dependent on cooperation of the child at the time of procedure, clinical skill of the dentist, and the ideal material of choice.

Majority of respondents prefer GIC over silver amalgam for the characteristic free fluoride ion release (92.96%) and cariostatic effect (81.69%). Studies by Togoo R et al [2], Madhavan S [4], Carey CM et al [44], and Lucas ME et al [45] also described extensive use of GIC by practitioners was due to the release of fluoride ions to the surrounding tissues providing secondary caries inhibition particularly in children. Fluoride in Glass Ionomer cement acts by attracting calcium and phosphate ions in the saliva with partially dissolved enamel crystallites and promote crystal re-growth, re-crystallization and new mineral deposition. Simultaneously, the calcium apatite crystals are replaced by hard and rapid deposition of fluorapatite thus forming a stable, more resistant surface layer to further demineralization with subsequent resilient to penetration of the calcium and phosphate ions required for re-establishing the deep carious lesion.

Recent studies by Wiegand A et al [46] and Burke FM et al [47] have shown fluoridated amalgam produced cariostatic effect by releasing fluoride ions gradually and thus decreasing the recurrence of secondary caries around the restoration. These results shows the need for dental students to make assessment of restorative materials considering all the factors with utmost care as the majority of the dental professional believe extent of caries and psychological impact largely influences the overall successful treatment outcome in paediatric population.

Conclusion:

Within the limitations of the study, it was evident that majority of the undergraduate and postgraduate dental students were aware of advantages and disadvantages of GIC over silver amalgam. However no scientific evidences available to rule out amalgam based on mercuric toxicity alone and it was also noted that a trend of higher treatment need in children for aesthetics influenced the choice of material. Thus, dental students and professionals must educate their patients who prefer amalgam restoration over tooth coloured materials by imparting clear understanding of distinctive features, strengths, and weaknesses of each material based on the clinical condition rather than on choice of their own by personal influences.

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Graph:

Graph 1: Graph showing the overall knowledge score among the study population:

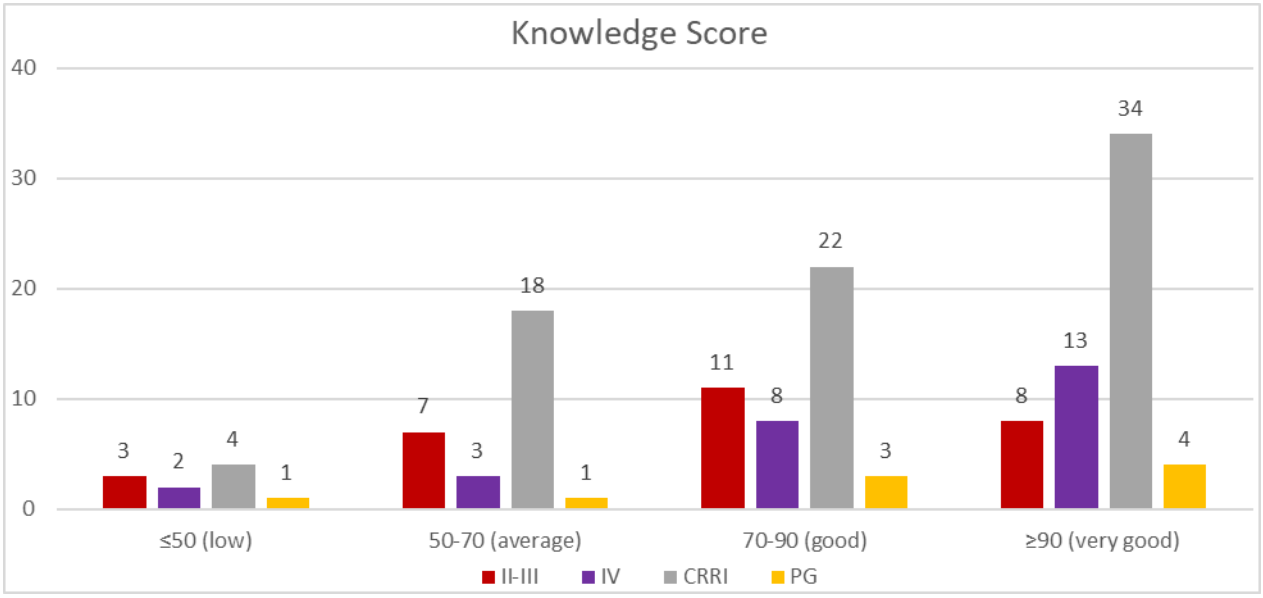

Table 1 : Table showing the Questionnaire Responses (N %) among the study Population

S NO	QUESTIONS	OPTIONS	II-III Years N (%)		IV years N (%)		CRRI N (%)		PG's N (%)		TOTAL N (%)		p-value
1	Which of the following materials can be used to restore in children?	GIC	28	96.5%	26	100%	78	100%	9	100%	141	99.3%	**<.0001***
		Silver Amalgam	1	3.45%	0	0.00	0	0.00	0	0.00	1	0.7%	

2	Which restorative material is comparatively durable?	GIC	13	44.8%	12	46.15%	70	89.74%	7	77.78%	102	71.83%	**<.0001***
		Silver Amalgam	16	55.1%	14	53.85%	8	10.26%	2	22.22%	40	28.17%	
3	For which of the following material is less complicated for cavity preparation?	GIC	25	86.2%	23	88.46%	77	98.72%	8	88.89%	133	93.66%	.05495
		Silver Amalgam	4	13.7%	3	11.54%	1	1.28%	1	11.11%	9	6.34%	
4	Which has a characteristic of free fluoride ion release?	GIC	24	82.7%	24	92.31%	76	97.44%	8	88.89%	132	92.96%	.0645
		Silver Amalgam	5	17.2%	2	7.69%	2	2.56%	1	11.11%	10	7.04%	
5	Which of the following is highly biocompatible?	GIC	26	89.6%	25	96.15%	76	97.44%	8	88.89%	135	95.07%	.3149
		Silver Amalgam	3	10.3%	1	3.85%	2	2.56%	1	11.11%	7	4.93%	
6	Why you think silver amalgam is not advised for paediatric patient?	Mercury toxicity	4	13.7%	1	3.85%	1	1.28%	1	11.11%	7	4.93%	.2468
		Delayed expansion	1	3.4%	2	7.69%	2	2.56%	1	11.11%	6	4.23%	
		Galvanic corrosion	2	6.9%	2	7.69%	4	5.13%	1	11.11%	9	6.34%	
		All the above	22	75.8%	21	80.77%	71	91.03%	6	66.67%	120	84.51%	
7	Mucosal reaction caused by amalgam is called	Amalgam mucositis	1	3.4%	4	15.38%	11	14.10%	2	22.22%	18	12.68%	.2765
		Amalgam tatoo	27	93.1%	20	76.92%	66	84.62%	6	66.67%	119	83.8%	
		Amalgam keratitis	1	3.4%	2	7.69%	1	1.28%	1	11.11%	5	3.53%	
8	Consedering the hazards of mercury in amalgam, do you think it can be replaced?	YES	21	72.4%	22	84.62%	76	97.44%	8	88.89%	127	89.4%	**.00197***
		NO	8	27.5%	4	15.38%	2	2.56%	1	11.11%	15	10. 5%	
9	Do you think GIC cause any reaction in oral mucosa?	YES	5	17.2%	3	11.54%	11	14.10%	1	11.11%	20	14.1%	.9310
		NO	24	82.7%	23	88.46%	67	85.90%	8	88.89%	122	85.9%	

10	Do you believe the presence of fluoride in GIC has a cariostatic effect?	YES	20	68.9%	23	88.46%	68	87.18%	5	55.56%	116	81.7%	.0742
		NO	4	13.7%	1	3.85%	2	2.56%	1	11.11%	8	5.63%	
		MAYBE	5	17.2%	2	7.69%	8	10.26%	3	33.33%	18	12.6%	