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Marginal Integrity of Class-I Restorations, Restored with Amalgam and Bonded Amalgam; A Comparative Study

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ABSTRACT

Objective: To compare the marginal integrity of Class-I amalgam and bonded amalgam restorations in maxillary and mandibular molars at seven days, three, six and twelve-months intervals.

Study Design: Comparative prospective study.

Place and Duration of Study: Department of Operative Dentistry, Armed Forces Institute of Dentistry, Rawalpindi Pakistan, from Jul 2017 to Jul 2018.

Methodology: A total number of 114 patients of either gender with an age range of 14-45 years having Class-I cavities in first and second maxillary and mandibular molars on both sides were equally distributed in two groups. Group-A received conventional Amalgam, and Group-B received bonded amalgam restorations. All the fillings were placed and carved using routine instruments used for amalgam restorations, and the restorations were polished after 24 hours. The patients were initially evaluated for marginal ditching around restorations with the help of a dental mirror and explorer at seven days, followed by inspection at 3, 6 and 12 months.

Results: Of the 114 participants, all showed excellent marginal integrity at seven-days intervals regardless of the restorative material used. However, marginal integrity deteriorated swiftly with time among those 57(50%) participants who acquired conventional Amalgam. Marginal integrity at 3, 6 and 12-months period was 51(89.5%), 35(61.4%) and 17(29.8%), respectively. Bonded amalgam restorations performed superiorly with 100%, 56(98.2%) and 43(75.4%) successful marginal integrity at 3, 6 and 12-months, respectively.

Conclusion: Bonded amalgams can be a better substitute than non-bonded amalgam restorations with superior longevity in marginal integrity.

Keywords: Amalgam, Bonded amalgam, Marginal integrity, Micro-leakage, Marginal deterioration, Restoration longevity.

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INTRODUCTION

Dental caries is a substrate-derived multifactorial disease that results in the cyclic demineralization and remineralization of dental hard tissues.[1] This is a preventable disease through appropriate oral hygiene maintenance procedures using fluoride toothpaste and newer antimicrobial agents.[2] Dental Amalgam is composed of a mixture of metal alloy mixed with liquid mercury having excellent durability, strength and stability under high occlusal load. They are easy to use, quick to place, and relatively cost-effective.[3,4]

Conventional Amalgam is a restorative material that fills the space of the prepared cavity rather than strengthening the tooth and restoring the fracture resistance of the tooth, which was lost during cavity preparations.[5] Additionally, cutting healthy tooth structure is bound to happen to achieve good resistance and retention for amalgam restorations.[6] Further, immediate microleakage occurs following insertion, as Amalgam does not make a bond to the tooth structure.[7] So, to overcome these demerits of Amalgam, researchers introduced adhesive systems to bond such restorations to enamel and dentin reliably.[8] One study showed that adhesion occurs between Amalgam and the tooth surface with the help of bonding, which implies that there is reduced dependence on macro-mechanical retention, which allows more conservative cavity preparation without the need for pins.[9] It also creates a better marginal seal and enhances natural tooth strength and fracture resistance, thereby decreasing the risk of dentine and pulpal infectivity, along with a lower incidence of secondary caries and reduced post-operative sensitivity.[10]

Several studies have been done to assess the marginal integrity of conventional and bonded amalgams; however, we needed to investigate this topic due to insufficient local data. Therefore, this study aimed to assess the marginal integrity of Class-I restorations, restored with Amalgam and bonded Amalgam, to give general practitioners better alternatives for the long-term survival of restorations.

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METHODOLOGY

After taking approval from the Ethical Review Committee (IRB Number 90/Trg – ABP1K2), the study was conducted at the Department of Operative Dentistry, Armed Forces Institute of Dentistry from July 2017 to July 2018. Non- probability consecutive sampling was carried out. The sample size was calculated, using the test for two independent proportions, with the anticipated population proportion of Bonded Amalgam at 0.99 and Amalgam at 0.82, keeping the power of the test at 80% and significance level at 5%.[11]

Inclusion Criteria: Patients of either gender with an age range of 14-45 years having at least one Class-I carious lesion in either first or second maxillary and mandibular molars, were marked as suitable candidates for inclusion into the study.

Exclusion Criteria: Patients with poor oral hygiene or suffering from any systemic disease, malocclusion, or any other dental anomaly were excluded from the study.

The patients selected were regular attenders of the clinical practice and were recalled at least four times after restoration placement for evaluation. All the restorations provided were intended to be permanent, and they were not envisioned as a core for crowns during this study. In case of failure of restoration, the restoration was not repaired but replaced completely. Patients were divided into two Groups, A and B. Informed consent was taken, and the detailed oral examination followed the history of the patient. After matching and controlling for confoun-ders like patients and operator variations, teeth were restored with bonded and non-bonded Amalgam. Conventional non-bonded amalgam fillings were done in Group-A patients, while bonded amalgam (Adhesive Amalgam bond) was used in the cavities of Group-B patients. All restorations were placed by the principal investigator and carved using routine instru-ments used for amalgam restorations. After 24 hours, the restorations were polished using the SHOFU polishing system. The patients were evaluated for marginal ditching around restorations according to the modified United States public health service criteria,[12] where marginal integrity was investigated with a dental mirror and explorer for conventional Amalgam and bonded amalgam restorations at seven days initially. After three months, patients were recalled, and the restorations were examined according to the criteria followed by assessment at 6 and 12 months, respectively.

Data were analyzed using Statistical Package for the social sciences (SPSS) version 23.00. The values of marginal integrity at seven days, 3, 6 and 12-months were cross-tabulated for both groups, and the Chi-square test was applied. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

One hundred fourteen participants were included in the study, equally divided into Groups A and B, with Amalgam and bonded amalgam restorations, respectively. The mean age of patients who received Amalgam was 26.19±7.63 years and those who received bonded Amalgam were 28.51±7.57 years. Distribution of teeth according to the restorative material used was 61(53.5%) mandibular 1st molars, 33(28.9%) mandibular second molars, 16(14.0%) maxi-llary first molars and 4(3.5%) maxillary 2nd molars restored (Table-I).

Table-I: Distribution of Teeth with Restorations (n=114)

Restoration Material	Restored Teeth			
	Mandibular 1st Molar (n=61)	Mandibular 2nd Molar (n=33)	Maxillary 1st Molar (n=16)	Maxillary 2nd Molar (n=4)
Amalgam	32(56.1%)	12(21.2%)	11(19.3%)	2(3.5%)
Bonded Amalgam	29(50.9%)	21(36.8%)	5(8.8%)	2(3.5%)

At seven days intervals, none of the restorations in both groups showed any evidence of marginal breakdown upon inspection. However, at three months of follow-up, 6(10.5%) restorations had undergone marginal deterioration in Group-A, while all restorations in Group-B were still intact. After six months intervals, 22(38.6%) amalgam restorations suffered marginal defects, but bonded amalgam restorations endured oral conditions, and only 1(1.8%) restoration showed marginal breakdown (*p*-value <0.001). Only 17(29.8%) survived marginal breakdown 12-months interval, and 40 restorations (70.2%) had undergone marginal breakdown, however, bonded Amalgam yielded better results with 43(75.4% successful restorations and only 14(24.6%) restorations failed upon inspection according to the criteria. The (*p*-value <0.001) suggested a highly significant associa-tion at six months and 12-monthly intervals, shown in Table-II.

DISCUSSION

In the present study, marginal integrity was investigated with a dental mirror and explorer for conventional Amalgam and bonded amalgam restorations. The results showed promising results for the

marginal integrity of bonded amalgams even after one year.

Table-II: Comparison of Marginal Integrity at 7 Days, 3, 6 and 12 Months in Teeth Restored With Amalgam and Bonded Amalgam (n=114)

	Restoration Material		*p*-value
	Amalgam (n=57)	Bonded Amalgam (n=57)	
Marginal Integrity at 7 Days			
No	0(0%)	0(0%)	*
Yes	57(100%)	57(100%)	
Marginal Integrity at 3 Months			
No	6(10.5%)	0(0%)	0.012
Yes	51(89.5%)	57(100%)	
Marginal integrity at 6 Months			
No	22(38.6%)	1(1.8%)	<0.001
Yes	35(61.4%)	56(98.2%)	
Marginal Integrity at 12 Months			
No	40(70.2%)	14(24.6%)	<0.001
Yes	17(29.8%)	43(75.4%)	

**No statistics were computed as marginal integrity at 7 days was a constant.*

Much prior research has been conducted to determine the marginal integrity of restorations with time with different methods.[12] Agnihotry *et al.*[13] assessed the effects of adhesive bonding on the performance and longevity of dental amalgam restorations by assessing the marginal disintegration of restorations at the occlusal and proximal surfaces. The researchers stated that there was no substantial difference between the groups under consideration in their marginal adaptation at both baseline and 24 months.

Bonded amalgams not only increase the amalgam retention but also seal the dentinal tubule, decreasing post-operative sensitivity caused by amalgam restorations. Moreover, the formation of corrosion by products in later stages after placement superimposes the sealing of the tooth restoration interface. This factor can also lead to more stable marginal integrity in bonded amalgams. However, further research is vital to determine the exact mechanism.[14] A study by Kemaloglu *et al.*[15] determined alterations after one year in marginal discolouration, marginal integrity, anatomical design, and surface roughness for bonded Amalgam and composite and concluded with satisfactory results for both composites & bonded Amalgam for use in posterior cavities, making bonded amalgams a viable option when strength is also desirable.

A study by Setcos *et al.*[16] reported no significant differences between bonded and conventional amalgam restorations when evaluated for anatomic form, marginal adaptation, surface quality, and temperature sensitivity 4, 7, and 24 months from preparations with no deliberate retention. Interes-tingly, this study shows better survival and longevity of bonded amalgams at the cost of additional chair side time and expenditure. Naz *et al.*[17] concluded that no difference was noticed in the marginal breakdown of conventional and bonded amalgam fillings, and the use of bonding agent only adds to clinical time and cost and pose more technical challenges.

A Cochrane review by Murad *et al.*[18] found no variance in survival between bonded and non-bonded amalgam restorations. However, only one trial was considered methodologically reliable. It stated no considerable difference in the functioning of adhesively bonded amalgam restorations in terms of their survival rate and marginal integrity compared to non-bonded amalgam restorations over two years.

Despite the assuring results of this study, some limitations, like restorations were placed only in Class-I cavity design and using other cavity designs, may have influenced the results. In addition, restorations were evaluated at a maximum time interval of one year, but the prolonged time of up to five years could lead to different results.

CONCLUSION

Within the limitations of the study, bonded amalgam restorations revealed better marginal integrity as compared to conventional amalgam restorations, and therefore, it is more advantageous to patients. In addition, bonded amalgams can be a superior substitute to non-bonded amalgam restorations with superior longevity.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MJAR & MAR: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

SB & AYB: Conception, study design, data interpre-tation, approval of the final version to be published.

SI: Critical review, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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