Review Article

Amalgam and Composite Restoration in Posterior Teeth

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Abstract

Basically most of the dentists choose amalgam for posterior restorations and they think amalgam is safe and poses no health risk to the patient. They also think that amalgam is the best material for posterior restoration as it can bear more masticatory stress, low price, easy to manipulate and also easy to handle/ place into the cavity. Moreover, their perception regarding amalgam is also very positive such as it is durable, the percentage of cusp fracture is less, no shrinkage and it has no toxic/harmful effect for oral health and general health also. But now a days controversy arises about this type of thinking in many clinical researches. Furthermore, composite became very popular to the dentist because of esthetic, two types of bonding (mechanical & chemical), less sound tooth structure have to remove, no harmful effect like mercury of amalgam, marginal leakage is less, cusp fracture is less, secondary caries detection easier than amalgam by radiograph, composite takes good polish, etc. But composite resins also have some disadvantages. This article has been prepared to give a picture on merits, demerits and different aspects of comparison on amalgam and composite restorative materials after reviewing different articles and publications.

Key Words: *Amalgam, Composite.*

Introduction

In the early stage of dentistry, the father of modern Dental science. Black in 1890 classified carious lesions by location. As restorations essentially conform to caries location, the cavities that require being prepared are similar by classification. Since then only one more category has been added to his classification. Previous class 1 to class 5 and then added class 6 (Fig1).

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Basically Black's classification is widely used for Amalgam restorations. Silver-tin alloy has been used as a filling material for teeth for over hundred years, mercury is present in the silver filling materials called amalgam. There are many types of amalgam [type 1: a) high copper alloy b) low copper alloy c) gallium alloy; type 2: a) lathe cut b) spherical particle; type 3: a) zinc containing b) zinc free]. Silver tin amalgam is most commonly and widely use in dentistry. It commonly consists of mercury 50%, silver (~22-32%), tin (~14%), copper (~8%) and other trace materials[1,2]. After establishment of MI (minimal intervention) concept what was adopted by the FDI General Assembly in 1st October, 2002 in Vienna, the popularity of composites are increasing day by day as filling material for anterior and also for posterior teeth (Fig 2). Composites filling are primarily a resin which has been "filled" with other organic and inorganic materials. This compound makes a composite filling more resistant to a wear, color adjustable, and easier to polish. The advantages of choosing a composite filling included more natural appearance, frequently a strengthening of filled tooth and a bonding of the filling to the tooth creating a better seal. Previously composites were used only for anterior tooth restoration in the sense of aesthetic view. After hybridization of composite resin, it is popular for posterior teeth restoration. Many branded with different shade composites are available now. Composites are mainly consist of a. resin matrix (organic content) b. fillers (in organic part.) c. coupling agent between fillers and matrix resin d. coloring agents. The composites are mixed with fillers to stabilize and complete the mixture, making it stronger and safer.

Toxicity and Health hazard

Recently the popularity of amalgam restoration has diminished by the cause of health hazard, concerns about the toxicity of mercury made its use increasingly controversial due to a worldwide plan to phase out the use of mercury[3]. Dental amalgam is a source of low-level expose of mercury, and concern has been raised about whether this poses a health hazard. Despite considerable investigations, no scientific evidence links it as a cause of clinically significant toxic effects, except for the rare local hypersensitivity reaction. The American Association Council on scientific affairs concluded that both amalgam and composite materials are effective and safe for tooth restoration[4] and the national Institutes of Health have stated that amalgam fillings pose no personal health risk, and that replacement by non-amalgam fillings is not indicated [5]. Recent random clinical trial has also established that amalgam is safe, finding no evidence of neurological harm or deleterious renal effects associated with their use in children after examining a period of 5-7 years following treatment [6,7]. However, these studies did not address long-term effects[8]. The preparation of amalgam could pose a potential health hazard to dental workers who work with mercury compounds in relatively high concentration. Because mercury is regulating waste in some countries, its disposal can be costly. On the other hand composite poses no health hazard and it does not have any toxic effect.

Figure 1: Showing the GV Black classificationof cavity preparation

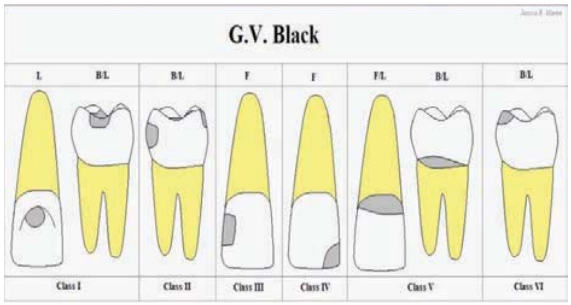

Fig 2: howing the MI based cavity preparation

Cavity preparation, retention system and MI (minimal intervention) concept

In case of amalgam restoration cavity preparation is more important because of retention system. Amalgam filling mechanically binds with the tooth structure and performing as a functional unit. For composite restoration cavity preparation is not important. For composite restoration cavity is totally different from amalgam restoration cavity, no need of extension, retention-like undercut. In case of composite restoration two types of bonding acts mechanical and chemical.

In case of amalgam restoration during cavity preparation some sound tooth structure should be removed for proper shape of the cavity and for retention of the restoration but in case of composite restoration no need to remove sound tooth structure. In minimal intervention technique no need to cavity preparation for composite restoration, just remove the caries involving soft dentine. There are circumstances in which composite serves better than amalgam. For example, when a more conservative preparation would be beneficial, composite is the recommended restorative material.

This situation would include small occlusal restorations, in which amalgam would require the removal of more sound tooth structure[9], as well as in "enamel sites beyond the height of contour"[10]. For composites purposes, composite is perfect when a restoration is required on an immediately visible portion of tooth. Composite resin can bound to previously cured material, even after oxygen inhibition layer is removed, if the cured surface is etched with phosphoric acid and then coated with a chemically compatible bonding agent [11].

Unfavorable condition and control of moist

Some practitioners strongly favor amalgam use in specific situation, and some find they cannot treat certain situations without amalgam, area in which moisture control is difficult. Deep box forms on any posterior teeth pose a clinical challenge for placement of resin-based composite, because of the frequent risk of moisture contamination. This condition is especially critical on the distal surface of the most posterior molars. Often, moisture seepage is unavoidable in or around the best placed matrix strips used highly competent clinicians. Amalgam is the choice of many dentists in these situations. An alternative treatment for those areas for dentist not using amalgam is placing resin-modified glass ionomer as the first 2mm of the restorative materials in the depth box form (Fuji Filling LC [GC America], or Ketac Nano [3M ESPE]), and curing it. The matrix strip is then moved occlusally, and resin-based composite is placed in the reminder of the restoration. This concept provides adequate aesthetic appearance, radiopacities for future diagnosis, fluoride release, and greater patient acceptance than amalgam[12].

Amalgam is "tolerant to a wide range of clinical placement conditions and moderately tolerant to presence of moister during placement"[13]. In contrast the techniques for composite resin placement are more sensitive to many factors and require "extreme care"[14].Mercury has properties of a bacteriostatic agent whereas TEGMA (constituting some older resin-based composites) "encourage the growth of microorganisms"[3].

In case of large posterior restoration

In case of large posterior restorations involve most of the occusal surface of the affected teeth. At least 2 major reasons why many dentists still choose to use amalgam in these situations. The time involvement to place large resin-based composite restorations in posterior teeth is well-known by most dentists to be excessive when compared to amalgam. However, experienced resin user may disagree with the preceding statement. Additionally, more than 4 decades of clinical observations show the wear of most resin-based composite materials to be greater than the wear of amalgam[15].This wear challenge is being overcome by improvements in resin-based composite materials[16]. A rebuttal to the above use amalgam is that the most appropriate treatment for such broken down teeth is placement of crown at greater expense.

Aesthetic and patients satisfaction

For esthetic purpose composite is the first choice as restorative materials. Most modern days composites are made available in numerous shades and several variations in opacity making possible excellent optical matches to the tooth structure. In case of composite restoration, using layering technique can result in a high level of esthetic (Fig 3). Now a days most of the patients choose tooth color filling. They want to avoid black filling for posterior teeth also because of aesthetic purpose. Patient demand and satisfaction both are important to a dentist about restoration. Maximum patients are satisfied with the tooth color filling for more natural look.

Fig 3: Showing the different aesthetic view of amalgam and composite restoration.

Thermal expansion and thermal diffusion

The coefficient of thermal expansion (CTE) of amalgam is similar to that of hybrid composites, which is approximately twice the CTE of human enamel and dentin. Another major difference is seen in the coefficient of thermal diffusion (CTD). Amalgam transmitted temperature approximately 15 to 20 times faster than do composite resins[17]. Considering the temperature and duration of thermal effects determined with "in vivo thermo-cycling studies[18-21], it can be assumed that amalgam restorations clinically expand and contract considerably more than composite resin. This cyclic dimensional change may be contributed to the fatigue of the tooth structure and to the cusp fracture. The physical properties of amalgam (creep, flow, CTE/CTD, corrosion, etc.) contribute to the typical fracturing of the margins, generally known as "ditching". The marginal quality of amalgam restorations decreases more rapidly than direct composites[22].

Creep and flow

Amalgam permanently deforms under pressure. With larger amalgams, occusal loading and flow could possibly create additional lateral stress at the buccal and lingual enamel.

Cusp deformation

The condensation of amalgam bends the remaining cusps outwards[23], and the setting reaction of filling type amalgams produces a slight expansion, which may add additional stress.

Corrosion

Amalgam is not a stable material in the corrosive environment of the mouth; it continues to react for many years. Although the corrosion-prone Gamma 2 phase is reduced or eliminated in modern high –copper amalgams, the main Gamma 1 phase is itself a weak bounded compound. Slow but continuous phase shifts to Beta 1 with release of mercury occur, and this sense, corrosion and dimensional change never stop[24]. It has been proposed that corrosion may produce additional lateral stress on cavity walls because product of corrosion occupy a large volume[25]. High copper amalgam containing zinc seems to provide clinical performance. It is proposed that zinc helps protect Gamma 1 phase[26]. However, this amalgam also expands significantly if moisture contamination is present during placement. A clinical study indicates a high incidence of bacterial penetration into dentin under apparently intact amalgam fillings[27].

Marginal leakage

Bacterial micro leakage under amalgam restoration also has been determined in vitro[28]. In fact, amalgam restorations nearly always show 100% leakage and could be considered as an excellent negative group in micro leakage studies[29]. The use of flow able composite liners has been claimed to increase marginal adaptation in the gingival marginal area of class 2 restoration thereby reducing micro leakage. It has also been claimed to modify polymerization shrinkage stress on the part of composite resin due to the more elastic nature of flow able composite resins.

Recent work has shown that the use of flow able liner showed fewer voids at the interface of the restoration and tooth structure in the cervical area of class 2 restorations when compared with packable resin composite alone[30]. The study also showed that thicker (2mm) flow able pre-cured liners showed more marginal leakage when compared with thinner (0.5-1mm) liners. This finding would obviously refute the notion that flow able liners could counteract the effects of polymerization shrinkage stress from the composite resin. Finally, this study showed that a lining technique originally presented by Jackson and Morgan[31] involving placement of a packable composite over a thin uncured flow able liner is the best marginal sealing of all groups tested.

Restoration associated with fracture

Numerous statements and implications have been made that composite resin restorations in posterior teeth are less to be associated with fracturing of remaining cusps because they can be bounded so well to the tooth structure. The arguement makes sense from the stand point of materials science; however, it is not well supported with evidence. One study that observed 10,869 posterior teeth with amalgam or composite resin restorations in 1,902 patients found no significant difference in the prevalence of cusp fractures between two restorative materials[32].

Strength and longevity

Many dentists think that amalgam is superior to restorative material over resin based composites. They also thought that strength and longevity of amalgam restoration are more in the sense of bearing masticatory stress. The New England children's Amalgam Trial (NECAT), is a randomized controlled trial, yielded results "consistent with previous reports suggesting that the longevity of amalgam is higher than resin-based compomer in primary teeth[13,33] and composites in permanent teeth [13, 34]. Compomers were seven times as likely to require replacement and composites were seven times as likely to require repair[13].

Marginal decay and diagnosis of secondary caries

Recurrent marginal decay is a very important factor in restoration failure, but more so in composite restoration. Recurrent marginal decay was the main reason for failure in both amalgam and composite restoration, accounting for 66% (32/48) and 88% (113/129), respectively[35]. Polymerization shrinkage, the shrinkage that occurs during the composite curing process, has been implicated as the primary reason for postoperative marginal leakage [36,37] .

Diagnosis of secondary caries is more difficult with amalgam restorations than with composites. We have all seen the gray staining of adjacent dentin around older amalgam restorations, which makes visual evaluation more difficult. The extremely high radiopacities of amalgam also is disadvantage; the diagnosis of secondary caries can be more accurate with composites.

Clinically success and failure rate of posterior restoration

Since composite resins were first consideration as a potential replacement for dental amalgam, questions have been raised as to their suitability for such a critical role in dentistry. There are many reports complaining the success rates of the two materials, and by and large composite resins have shown acceptable performance even if not quite to the level of dental amalgam.

Matching the efficiency of dental amalgam as a public health measure is indeed beyond the reach of most restorative materials. Table 1 shows the results of one comprehensive study that followed over 1700 posterior restorations for a seven year period. Half of the patients received composite resin restorations while the other half received amalgam (Table 1). As evident from the table, amalgam restoration demonstrated fewer failures than composite resins over the seven year period, particularly in restorations with three or more surfaces where composite resins experienced a 50% failure rate in the largest restoration. This study also reported that the main reason for both the group was secondary caries. However, the proportion of failures due to secondary caries was higher in the composite resin group (88%) compared with the amalgam group (66%). It has been reported that the most frequent sites for secondary caries are the gingival margins of all classes of restorations [38, 39].

Table-1

MEAN ANNUAL SERVIVAL RATES OF COMPOSITE AND AMALGAM AFTER SEVEN YEARS (%)		
CHARECTARISTIC	AMALGAM	COMPOSITE
TOOTH TYPE		
Premolar	94.5	85.7
Molar	94.4	85.5
RESTORED SURFACES		
1	98.8	93.6
2	90.5	80.6
3	88.5	66.2
4 or more	81.8	50.0
SIZE		
Small	98.9	93.6
Medium	93.3	84.9
Large	89.5	74.3
ALL	94.4	85.5

Adapted from Bernardo et al. [38]

Conclusion

Amalgam and composite both have been widely used in dentistry for posterior tooth restoration for last several decades due to their several favorable properties. But many clinical research activities revealed that the performance of amalgam in posterior restoration is better than composite due to their longevity and strength. However many researchers have established that composite is better for posterior tooth restoration due to MI concept and aesthetic property. Thus, many controversy opinions exist among dentists regarding composite for posterior teeth till date. Actually, there are reasons for failure of posterior restoration; marginal leakage, bacterial growth and other causes that lead to secondary caries and followed by fracture of the tooth.

Due to the recent concept of caries treatment based on MI, it is essential to find out the new restorative materials which possess the ability to regenerate and remineralize both dentin and enamel. So, it is necessary to conduct continuous research for confirmation which (amalgam/composite) one is better for posterior teeth restorations. At the same time, it is crucial to add new molecule with both amalgam and composite to enhance their MI based performance.

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