

# Histological Evaluation to Study the Effects of Dental Amalgam and Composite Restoration on Human Dental Pulp: An in vivo Study

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## Key Words

Dental amalgam · Composite resin · Dental pulp · Inflammatory response

## Abstract

**Objective:** To study and compare the effects of dental amalgam and composite restorations on human dental pulp. **Materials and Methods:** One hundred sound premolars scheduled for orthodontic extraction were divided equally into two groups: group A, teeth restored with silver amalgam, and group B, teeth restored with composite resin. Each group was equally subdivided into two subgroups [extracted after 24 h (A-1 and B-1) or 7 days (A-2 and B-2)], and the histological changes in the pulp related to the two different materials at the two different intervals were studied. **Results:** It was found that after 24 h, the inflammatory response of the pulp in teeth restored with amalgam and composite was similar ( $p = 1.00$ ). However, after 7 days, the severity of the inflammatory response of the pulp in teeth restored with amalgam was less compared to that in teeth restored with composite ( $p = 0.045$ ). **Conclusion:** This study confirmed that amalgam continues to be the mechanically as well as biologically more competent restorative material. Composite could be a promising restorative material to satisfy esthetic needs for a considerable period of time. However, its biological acceptance is still in doubt.

## Introduction

Restorative dentistry deals with the treatment of tooth tissue defects, not only to control the disease, but also to principally restore the function as well as esthetics without compromising the biology [1]. Amalgam had always been used mostly in clinical practice, but for many years, a controversy has raged over the biocompatibility of amalgam restorations because of mercury [2]. Irrespective of the developments in the composites, the major controversies that still exist following clinical trials are its questionable functional, biological, and esthetic performance [3]. Therefore, the objective of this study was to investigate the histological response of the pulp following the restoration of teeth with the two most commonly used restorative materials in clinical practice: amalgam and composite resin.

## Materials and Methods

One hundred sound premolars (maxillary and mandibular) to be extracted for orthodontic treatment were selected from 30 patients between 14 and 25 years of age who visited the Government Dental College and Hospital, Mumbai, India. Preference was given to patients requiring extraction of at least two premolars, so that one side was restored with composite resin and the other with amalgam in order to evaluate the response to both materials in one

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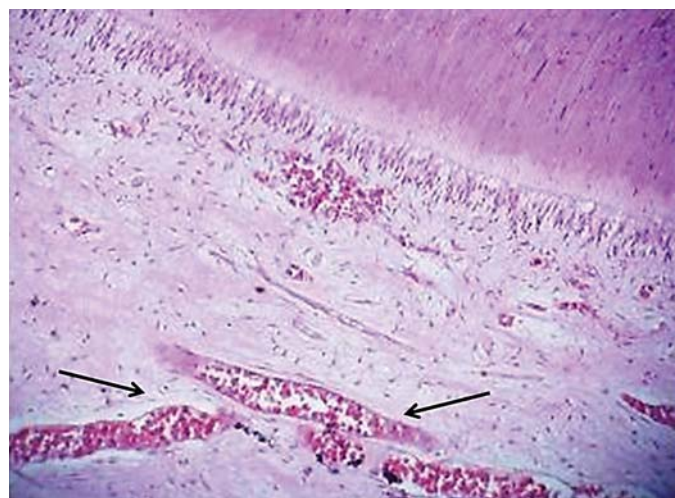
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patient. Written consent was obtained from each patient or parent if the patient was below 18 years of age. This study was approved by the Ethics Committee Board of the Government Dental College and Hospital, Mumbai, India.

The selected teeth were randomly divided into two equal groups and restored with class II amalgam (group A) and composite resin (group B). The teeth were further subdivided equally into two subgroups, i.e. 24 h (A-1 and B-1) and 7 days (A-2 and B-2) after extraction. All clinical procedures were done by one dentist (N.D.C.) under rubber dam isolation. The cavity cutting procedure was standardized and was used for both groups.

After anaesthetizing the tooth locally, a conventional class II cavity was prepared as described previously [4]. Each cavity was prepared with a new diamond point (SF 41 ISO 109/010 and SI 46 ISO 010/012, Mani, Japan) using air rotor (NSK, Nakanishi, Japan) as the coolant [5] and high speed [6] to reduce the aggravation of inflammatory response in the pulp. As an increase in the depth of the cavity aggravates the pulp response [7], the occlusal depth was maintained at a minimum level of 1.5 mm from the central groove. To achieve this depth, a straight fissure diamond point was coated with self-curing acrylic at a distance of 1.5 mm from the tip, so that only the required length of the point was available for cutting. Each cavity was cleaned with distilled water to prevent the action of any chemicals on the pulp and was dried with sterile cotton because air blasts increase the inflammatory response [8]. The matrix band and retainer were properly adapted to the tooth using plastic wedges of uniform sizes. For this study, the following materials were used: Dispersalloy (Dentsply), which is high in copper [9], an admixture of lathe-cut and spherical silver copper eutectic particles, and posterior composite (SureFil, Dentsply) filled 82% by weight (65% by volume) with a blend of fused silica and barium fluoroaluminoborosilicate glasses (average particle size 0.8  $\mu\text{m}$ ). Cavity varnish was applied to the walls of each cavity in groups A-1 and A-2 [10]. Manipulations of amalgam were done using an automatic amalgamator (Mixalloy, Rhoas) for each mix (0.06 g of this alloy triturated with 0.06 g of mercury for 10 s), condensed incrementally by hand followed by carving and finishing of the restoration. As all procedures were done by the same operator (N.D.C.), the condensation pressure was considered to be the same in all cavities and therefore also the pulp response. All amalgam restorations were intentionally left unpolished to prevent inadvertent changes in the response due to polishing [11], and as much finishing as possible was done during carving of the restoration.

For restoration of teeth with composite resin (group B), all cavities were etched using 36% phosphoric acid (DeTrey Conditioner 36, Dentsply) for 15 s to improve marginal integrity because pulp reactions to acid etchants have generally been rated as mild to moderate [12, 13]. Following thorough rinsing and drying of the cavity, a bonding agent (Prime and Bond NT, Dentsply) was applied followed by 20 s of curing using halogen light (CU-100, Unicorn). It was confirmed by radiometer that the light intensity of the device was not less than 400  $\text{mW}/\text{cm}^2$ , as a low intensity has a poor curing capacity [14]. The teeth were restored with composite resin at an increment of not more than 2 mm each time. Each increment was cured for 40 s according to the manufacturer's instructions ([http://www.surefil.com/sites/default/files/SureFil\\_Technical\\_Manual.pdf](http://www.surefil.com/sites/default/files/SureFil_Technical_Manual.pdf)). Additional curing was done over the restoration from all sides. Minor finishing, if required, was done to ensure occlusal integrity using finishing points for composite (Shofu). Necessary postoperative instructions were given to each patient of both groups.



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**Fig. 1.** Photomicrograph of amalgam after 24 h showing a number of dilated and engorged blood vessels suggestive of marked hyperemia.

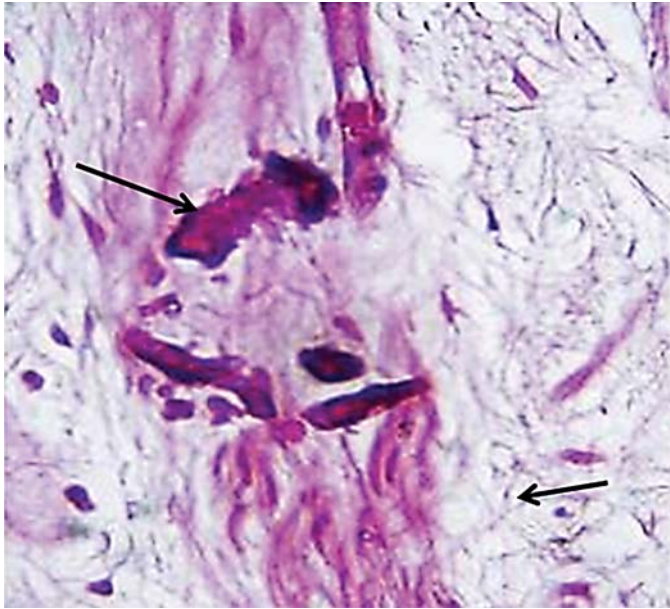
The patients were called after 24 h and asked about any postoperative sensitivity or any other discomfort they might have experienced. Immediately after extraction, the teeth were placed in 10% neutral buffered formalin for 96 h. After decalcification in 5% formic acid, the teeth were routinely processed, serially sectioned and stained with hematoxylin and eosin (HE) for histopathological interpretations. The entire histological processing was done in a professional laboratory by the coauthors M.Y. and J.V.T. They were blinded as to which teeth were restored with amalgam or composite. The inflammatory response of the pulp was evaluated as mild, moderate, and severe according to the criteria described previously [15, 16]. The histological observations of the two materials at a postoperative interval of 24 h and 7 days were compared.

## Results

The 24-hour postoperative histological evaluation of the 25 teeth restored with amalgam (group A-1) showed mild pulp response in 8 (32%), moderate pulp response in 12 (48%) (fig. 1), and severe inflammatory pulp response in 5 (20%) teeth. The corresponding inflammatory response of the 25 teeth restored with composite (group B-1) was as follows: mild pulp response in 7 (28%), moderate pulp response in 13 (52%), and severe pulp response in 5 (20%). The difference in pulp response to both materials at 24 h was statistically insignificant ( $p = 1.00$ ).

The 7-day postoperative histological evaluation of the 25 teeth restored with amalgam (group A-2) showed 15 (60%) teeth with mild response and 10 (40%) teeth with





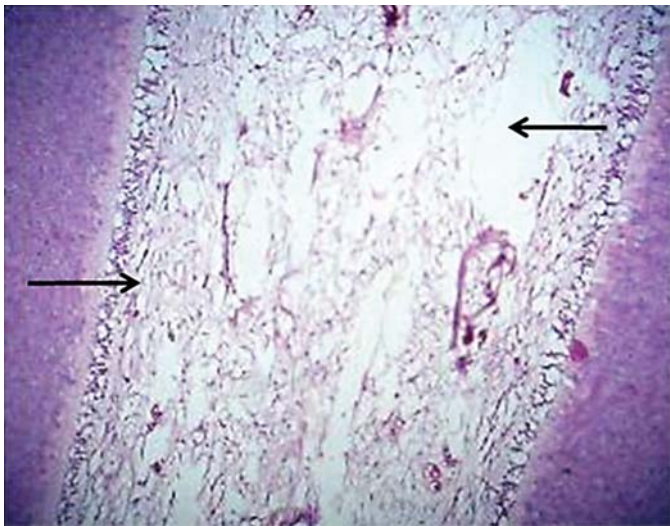
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**Fig. 2.** Photomicrograph of amalgam after 7 days showing foci of calcification and collagen fiber bundles. HE,  $\times 40$ .



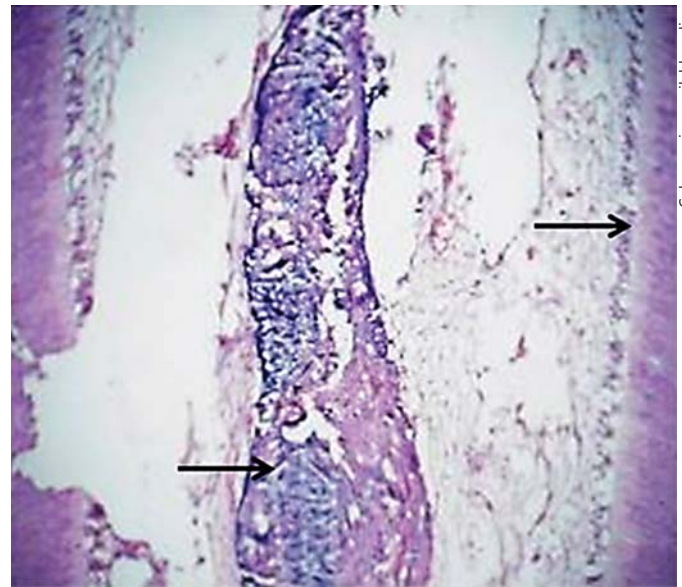
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**Fig. 3.** Dilated blood vessels with intravascular elements along with fibrosis and cavitation suggest severe response to composite after 7 days.



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**Fig. 4.** Photomicrograph of composite after 7 days showing moderate inflammatory cell infiltration along with abscess in the cavity.



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**Fig. 5.** Photomicrograph of composite after 7 days showing disintegrated odontoblastic layer with focal areas of necrosis. HE,  $\times 40$ .

moderate to severe response. Fibrosis (fig. 2) was evident in almost 8 (32%) teeth and abscess in 2 teeth, and necrosis was evident only in 3 of 25 teeth.

The corresponding response of the 25 teeth restored with composite (group B-2) showed mild inflammatory response in 7 (28%), moderate inflammatory response in 12 (48%), and severe inflammatory response in 6 (24%) (fig. 3). Special features were the number of abscesses (fig. 4) and necrosis (fig. 5) in 8 (32%) of the 25 teeth; fibrous bands were not seen in the slides of this group.

## Discussion

The results after 24 h indicate that whether the teeth were restored with amalgam or composite, 68–72% of teeth in each group (A-1 and B-1) exhibited similar inflammatory response of the pulp at a moderate to severe degree. Because the procedure for the preparation of the cavity was similar in both groups, etiological factors other than cavity preparation that contributed to the severity of the initial inflammatory response could be: the effect of local anesthesia [17], condensation pressure [18] and thermal conductivity of amalgam [19], micro-leakage between the tooth and restoration [20], and tooth extraction. Therefore, the immediate irritation of the pulp after 24 h could be attributed mostly to cavity preparation and trauma due to manipulation as previously reported [17–20], irrespective of the type of material used.

There was a significant reduction in the severity of inflammatory response of the pulp in amalgam after 7 days (A-2) as compared to composite (B-2). Seven days are considered to be a sufficient time elapsed to avoid the inclusion of transient pulp inflammatory activity resulting from cavity preparation and manipulation trauma. It is also expected that as time passes, the pulp inflammation should subside, and if this does not occur, the changes

seen in the later postoperative time intervals can mostly be attributed to the continuous irritation from the material [21].

The evidence of fibrosis in 32% of teeth restored with amalgam (A-2) is a proof that the healing potential of the pulp was increased, which could be attributed to the inertness of amalgam and its better sealing properties [10]. Various other studies [22, 23] have also demonstrated mild inflammatory pulp reactions under cavities restored with amalgam. However, no such evidence of healing was evident in any tooth restored with composite. On the contrary, necrosis and abscesses were evident in almost 32% of teeth of group B-2, which is a sign of aggravation of the inflammatory response. This can be attributed to the marginal leakage which is the result of polymerization shrinkage of composite resin [24], bacterial penetration beneath composite restoration [25, 26], its dimensional instability in the oral environment, curing method [27], restoration technique [28], and to some extent apoptosis [29] and cell death [30] through the seepage of uncured monomer in the pulp, and to their sealing and adhesion characteristics with cavity walls as well. As this is a short-term study, the results need not have been the same if the study was extended for a longer postoperative duration. Although this method represents a practical possibility for the preliminary evaluation of a new filling material, more information is needed to determine the progressive or reparative character of the initial changes.

## Conclusion

This study confirmed that amalgam continues to be the mechanically as well as biologically more competent material for restoration of teeth where esthetics may not be of primary concern. Composite could be a promising restorative material to satisfy esthetic needs for a considerable period of time.

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