A COMPARATIVE EVALUATION OF TOOTH STRUCTURE LOSS WHILE REMOVAL OF OLD COMPOSITE MATERIAL WITH AND WITHOUT USING METHYLENE BLUE DYE: AN IN-VITRO STUDY.

Dental Science

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ABSTRACT

Aims: A comparative evaluation of tooth structure loss while removal of old composite material with and without using methylene blue dye. **Materials and Methods:** 50 sound, non-carious permanent molar teeth extracted for periodontal reasons were collected and standard class II cavities (two-thirds of facio-lingual width, 1.5 mm pulpal depth and 0.5 mm inside the DEJ) were prepared and teeth were subjected to rehydration and dehydration. Tooth mass were recorded using digital analytical balance. Teeth were restored with composite resin and stored in distilled water at 37°C and thermocycled for simulating ageing process (5°C-55°C/5000 cycles). Samples were then assigned into 2 groups: Removal of composite restoration was carried out without and with using methylene blue dye in respective groups. Tooth mass was recorded again. Teeth were dissolved in 65% nitric acid for 6 days and weight of remaining composite material was assessed. **Results:** Loss of tooth structure was calculated using a structured formula. Loss of tooth structure was higher in GROUP A group with a t value of 1.408 but statistically not significant with a p value of 0.172. Comparison of the Remaining composite between the two groups showed that Remaining composite was higher in GROUP A group with a t value of 2.221 and is statistically significant with a p value of 0.039. **Conclusion:** loss of tooth structure and remaining composite was lower when methylene blue dye was used. This can help in preserving the natural tooth structure during replacement of failed composite restoration.

KEYWORDS

Dye; Old Composite Restoration; Removal; Tooth Structure Loss

INTRODUCTION

Composite restorations are among the most frequently used esthetic restorative materials in dental practice. Demand for composite resins has grown due to their ability to bond to enamel and dentin, their resemblance to teeth and good mechanical properties. With the development of new adhesives, curing systems and improvement in material properties, dental composites have now become the material of choice for restorative, aesthetic and post endodontic restorations.^[1] However, failures such as fractures, marginal staining, anatomical deficiencies, recurrent caries, dentin sensitivity and post operative pain are common with composite restoration and therefore they are technique sensitive.^[2]

Dental restorations are often considered as 'failed' when they do not meet certain standards that are designed by dental researchers and clinicians or when a patient experiences problems like pain, unpleasant aesthetic appearance etc. ^[3] In such failed restorations, intervention is needed in the form of either replacement or repair. ^[4]

Removal of such multi layered restorations can be time consuming, problematic and stressful for the dental practitioner because these life like restoration mimic the underlying tooth structure owing to the Blending effect or Chameleon effect. ^[5] While removing them there are chances of additional natural tooth structure loss which can weaken the tooth or compromise the remaining dentin thickness. Hence, needed is a disclosing agent which would differentiate the interface between the composite and the tooth and allow precise removal of such restorations without compromising the underlying healthy tooth structure. Many dyes have been used previously for this purpose. Methylene blue (MB) dye was found to be successful in distinguishing old composite from enamel. ^[6] However loss of natural tooth structure in terms of weight has not been measured previously while removal of old composite restoration.

So the aim of the study was to compare tooth structure loss after removal of old composite material with and without using methylene blue dye using microbalance. It was hypothesized that there will not be any difference in the weight of tooth calculated before and after removal of composite material with and without using methylene blue dye.

Materials and Methods

50 human permanent molar teeth extracted for periodontal purpose were selected. Teeth were viewed under magnification. Teeth with fracture, cracks, caries, demineralization, severe pitting, atypical intrinsic stains or previous restorations were excluded. The extracted teeth were disinfected in 0.5% chloramine T trihydrate solution for 1 week and cleaned off calculus and periodontal tissue using an ultrasonic scaler. All the teeth were then stored in normal saline at 4 degree until further processing. Before cavity preparation, teeth were mounted individually (Figure - 1).

Figure 1: Preoperative photo

Class II mesio-occlusal cavities were prepared in all the teeth with approximately two-thirds of faciolingual width, 1.5 mm pulpal depth and 0.5 mm inside the DEJ for axial wall using dental burs (245) and arotor under loupes (Insight DL-9174/1) magnification by the first operator (Figure - 2).

Figure 2: Class II Cavity preparation

All teeth were rehydrated for 24 hours in the saline. They were then placed on an absorbent paper towel and dehydrated. The dehydration process consisted of a series of ethyl alcohol rinses starting with 80% overnight, followed by 90% for 1 h and then 100% ethyl alcohol rinses for 1 h. All the sample were given the number and tooth mass was recorded using digital analytical balance (Adventurer Pro AVG264C-OHAUS, Melrose, Massachusetts, USA). The teeth were restored according to the manufacturer's instruction using universal bond (3M ESPE Scotchbond Universal Adhesive, USA) and nano hybrid composite (3M ESPE Filtek Z25 XT Nano Hybrid Universal, USA) in an incremental manner. Each increment was cured for 20 seconds. All the restorations were further characterized using tints. Final finishing and polishing was carried out using super snap (SHOFU, Super-Snap Composite Polishing Kit, USA) kit (Figure - 3).

Figure 3: Composite restoration and characterization with tints

The specimens were then subjected to storage in distilled water at 37°C for 2 weeks and thermocycled for 500 cycles in water for duration of 30 seconds in 5°C and 55°C alternatively with a time interval of 2 seconds to simulate ageing process. The samples were randomly divided (By flip coin method) according to the materials into 2 experimental groups of 25 sample each. Removal of the restoration in both the groups was performed by the second operator. For Group 1, Removal of composite was done using small round diamond point (BR40, Mani Inc, Japan) and airtor until sound tooth structure was visible under loupes without using dye and for Group 2; initially the composite material was removed from cavity using diamond point and airtor without any dye (Figure - 4).

Figure 4: Initial composite removal without using dye

In the deeper areas where differentiation between tooth and material was difficult, methylene blue dye (prepared by dissolving 1.0g of powder per 100ml deionised water) was applied with an applicator tip and immediately rinsed with water. Dye stained the tooth restoration interface which aided in removal of the remaining restoration (Figure - 5,6).

Figure 5: Staining of tooth by methylene blue dye (black arrow showing staining of interface between tooth structure and remaining composite; yellow arrow showing mildly stained composite)

Figure 6: Staining of remaining composite

The above step was repeated until no interface could be differentiated. Mild staining of composite restoration and tooth surface was observed after repeated application of stain (Figure - 7).

Figure 7: Proximal box after removal of composite (arrow showing light staining of tooth structure)

But the stained interface was well delineated. Rehydration and dehydration of teeth was repeated for the samples of both the groups as mentioned previously. And tooth mass was recorded using digital analytical balance.

Remaining composite tooth material was measured after decalcification of the tooth. Teeth were transferred in sterile container containing 6 ml of 65% nitric acid for 6 days. After complete dissolution of the tooth structure the remaining composite which was seen either suspended or at the bottom of the test tube was carefully collected and it was weighed using digital analytical balance. Following formula was used to calculate tooth structure loss:-

Loss of tooth structure = Weight of tooth structure after cavity preparation - (Weight of tooth after composite removal - Weight of remaining composite material)

The data thus collected was subjected to statistical analysis. Independent sample t test was done to draw comparison between two groups using IBM SPSS 2 software. For all statistical analysis, probability levels of $P < 0.05$ were considered statistically significant.

RESULTS

Using the already mentioned formula loss of tooth structure was calculated (Table - 1).

Table 1: Independent T test for comparison of two groups

	Group	N	Mean	Std. Deviation	t	df	P Value
Loss of tooth structure	GROUP A	25	0.0598	0.214515	1.408	24.008	0.172
	GROUP B	25	-0.0006	0.002754			
Remaining composite	GROUP A	14	0.0260	0.02186	2.221	18	0.039
	GROUP B	6	0.0055	0.006745			

Comparison of the loss of tooth structure between the two groups showed that loss of tooth structure was higher in GROUP A group with a t value of 1.408 and is statistically non significant with a p value of 0.172 (Graph - 1).

It was evident from the results that number of teeth with remaining composite was significantly more in group A as compared to Group B (Graph - 2).

Comparison of the remaining composite between the two groups shows that remaining composite was higher in GROUP A group with a t value of 2.221 and was statistically significant with a p value of 0.039.

Graph 1: Comparison between Group A and B for Loss of tooth structure

Graph 2: Comparison between Group A and B for Remaining composite

DISCUSSION

The common finding usually with composite restoration is deterioration and degradation leading to the need for further intervention. Common reason for this is secondary caries and post operative sensitivity generally lead to failure of restoration.^[7,8] Replacement of existing restoration is often associated with the inevitable and unnecessary loss of intact, healthy tooth tissue. Over the course of time, such interventions can lead to progressive loss of tooth structure and function and increased cost of treatment.^[9]

To prevent this, identification of old composite restoration from natural tooth structure is very important. The detection of existing composite resin is usually done by visual inspection under conventional illumination and tactile sensation but greatly depends on the experience and skills of the examiner.^[10] Ultraviolet light (UV) light in range of 265-380 nm is one of the most useful wavelength for detection of resins but it is very harmful for human body.^[11] Also, alternative light source and quantitative light-induced fluorescence (QLF) techniques have also been used to detect the composite resin. The drawback with these methods being fluorescence emission which is best visualized in a dark environment which is impractical in the dental office.^[12] Even though the visual inspection revealed similar results, the subjective methods are highly operator dependent and can lead to inaccuracy. In such situation use of disclosing dye can aid in visual identification of old composite. MB dye was chosen because it is inexpensive, simple and the usage of complex laboratory equipment is not required for it.

In the present study few observation were made. Initial application of dye led to staining of interface between tooth and composite (Figure-5). Further use of dye led to staining of composite (Figure- 6). Mild staining of dentine was visible only after repeated application of dye until all the composite was removed (Figure-7).

Composite resin stains more than the tooth structure with hydrophobic dyes indicating that composite is more hydrophobic than tooth.^[3] In the present study MB dye was immediately washed off after application. So it doesn't stain the composite or tooth structure immediately and only stains the interface between the composite restoration and natural tooth structure. However due to repeated application of dye the composite got stained at isolated areas. Methylene has a known molecular weight of 319.868 g.mol⁻¹, wavelength of 662 nm, color index of 52015, and surface area 120 Å. Also, the internal diameter of the dentinal tubules (1-4 μm) is larger than particle size of dye, so it is able to show dentin permeability.^[14] Sharma R. et al. used MB as a disclosing dye for composite resin for better visibility of boundaries

between composite resin and enamel.^[6] As both enamel and composite resin contain high amounts of hydrocarbons, they are best stained by the cationic methylene blue. Natural tooth structure is best stained by the hydrophobic dye. MB is hydrophilic in nature. This information was used to identify MB dye for composite removal.

In the present study class II mesiooclusal cavities were prepared in molars as failure of composite restoration are noted more in class 2 cavity design.^[15] Chrysanthakopoulos J et al. found that most placed and most replaced restorations were Class II.^[16]

Dehydration was done using different concentration of ethyl alcohol. It removes unbound water & aqueous fixatives from tissue component. The process uses ethyl alcohol in step wise manner of 80%, 90% & 100%.^[16] In the present study dehydration was carried out to measure the accurate weight of teeth. Dehydration of tooth can decrease the bond strength of composite but there is no reported study which shows complete bond failure. Hence objectives of our study did not get affected.

In the present study, as per previous literature, digital analytical balance sensitive to 0.0001g was used to measure tooth mass.^[17] Thermocycling simulates 6 months to 1 year of ageing process. Ren YF et al showed that there was no significant color difference, when thermocycling is carried out using water.^[18] Thermocycling of restored teeth didn't affect the composite shade in our study which otherwise could have led to easy identification and removal of composite.

60% Nitric acid was used in present study as it requires only 3 to 4 days for dissolution of teeth. As per Camps J et al., this technique is effective and faster and can be performed using equipment that is available in most dental schools.^[19] Nitric acid could also cause dissolution of remaining composite material which may affect the calculation of tooth structure loss in weight in the end. But this was observed with both the groups so it doesn't affect the result of study.

CONCLUSION

Methylene blue dye can help in differentiating composite restoration from the underlying natural tooth structure. The results can be applied clinically during replacement of failed composite restoration. This will help in preserving the natural tooth structure and can lead to decreased post-operative sensitivity, complications and hence lesser recurring cost to the patient.

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