



**UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE ODONTOLOGIA**



IGOR FIRMINO PEREIRA LEÃO

**EFFECT OF HANDPIECE LED AND GLASS
IONOMER BASE ON INTACT DENTIN
REMOVAL DURING ENDODONTIC RE-ACCESS
FOR ENDODONTIC TREATED TEETH USING
MICROCT ANALYSIS**

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MICROCT ANALYSIS**

Trabalho de conclusão de curso apresentado a
Faculdade de Odontologia da Universidade
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Effect of handpiece LED and glass ionomer base on intact dentin removal during endodontic re-access for endodontic treated teeth using microCT analysis

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Title: Effect of handpiece LED and glass ionomer base on intact dentin removal during endodontic re-access for endodontic treated teeth using microCT analysis

ABSTRACT

INTRODUCTION: Removal of restorative material and eventual removal of dentin should be a concern in cases of re-access for endodontic retreatment. The objective of this study was to evaluate the intact dentin removal on the surrounding walls and on the floor of the pulp chamber on molar teeth influenced by type of the direct restoration and illumination during cavity.

METHODS: 12 maxillary intact molar received occlusal root canal access and were endodontic treated by using rotatory instrumentation and root canal filling using AH Plus (Dentsply). Half of the samples were restored by using bulk fill flowable composite resin (Opus Bulk Fill Flow, FGM) for filling dentin structure and conventional composite resin (Opallis, FGM) for restored occlusal access. The other half, the teeth were restored using conventional glass ionomer (Maxion R, FGM) for filling the pulp chamber (1.5mm) and conventional composite resin (Opallis, FGM). Half the samples were re-accessed using high-speed handpiece with or without the use of UV light. The teeth were scanned by using microCT before and after the root canal re-access and the dentin accidentally removal was evaluated. The dentin removal was classified regarding the dentin removal on pulp chamber base dentin or lateral dentin.

RESULTS: No significant was observed regarding lateral dentin after re-intervention cavity irrespective on the restorative protocol or illumination process. However, the use of glass ionomer cement reduce the dentin accidentally removed on the floor of the pulp chamber.

CONCLUSIONS: The use of the high speed handpiece with violet light had no effect for avoid dentin removal on lateral walls and the base of the pulp floor. However the use of conventional glass ionomer reduce the dentin accidentally removed on the floor of pulp chamber.

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INTRODUCTION

Restoring endodontic treated molar teeth (ETMT) is a challenge for clinicians, since extensive damage to dental structure occurs, either by caries or by endodontic access¹. Several materials have been indicated for restoring ETMT such as conventional composite resins or bulk fill composite resins associated or not with glass ionomer cement (GIC)². Bulk fill composite resin is used in a 4-6 mm of increment^{3, 4}, facilitating the restorative procedure with less time consume⁵. The use of conventional or resin modified glass ionomer cement GIC for filling the pulp chamber base have been used to reduce shrinkage stress generated at the interface of ETMT⁶, and decreasing the cusp deformation and to improve fracture resistance of ETMT restored with composite resin⁷.

When endodontic treatment failure, a new access to the canals should be performed, and the capability to distinguish between dentin and the material can determine less or greater wear of the intact walls of the lateral dentin or in the floor of the pulp chamber. Such re-intervention procedure aims to completely remove the restorative material, the root canal obturation to allow effective cleaning, shaping and re-obturation of the root canal⁸. Occasionally, the coronal preparation and the root access may result in intact dentin removal, and in extremely situation in accidental perforation of the pulp chamber, which is among the main complications of endodontic-restorative treatment⁹, and is considered one of the major causes of failure of endodontic treatment¹⁰. For removal of these materials and endodontic re-access, usually a conventional high-speed handpiece with a spherical diamond bur has been used. Some of the restorative materials present higher fluorescence that make more visible when exposed to ultraviolet¹¹. New high-speed handpiece feature a violet LED headlamp system that highlights the fluorescence of the restorative material in contrast to that of the dental structure and which could facilitate the selective removal of the composite and reducing unnecessary wear to the structure compared to conventional high-speed handpiece. In authors knowledge, no study has tested the efficiency of the effect of using GIC layer for fill pulp chamber base and the interaction of composite resin with violet LED high-speed handpiece to prevent iatrogenic intact dentin removal during endodontic re-intervention. Therefore, the aim of this was no statistically significant difference in dentin wear promoted for re-intervention access cavity between groups restored with glass ionomer on the floor and composite resin on the occlusal surface, with those with bulk fill resin on the floor and composite occlusal resin, regardless of the method of removal used.

MATERIALS AND METHODS

Teeth selection and Access

This study was approved by ethic committee of Federal University of Uberlândia (ID: 2.570.199). Twenty intact human upper molar teeth with roots and crowns of similar proportion were included according to the technique described by Soares et al¹². The teeth were endodontic treated by conventional access by using round diamond bur (#1014, KG Sorensen, Cotia, SP, Brazil) in high-speed handpiece (Kavo, Joinville, SC, Brazil) under refrigeration up to achieve the pulp chamber when it was used Endo-Z drill (KG Sorensen, Cotia, SP, Brazil) to ensure the cavity contour allowing the location of canal orifices.

Canal Instrumentation and Obturation

The teeth were instrumented 1,0 mm above the apical foramen. Prodesign S system (Easy Equipamentos, Belo Horizonte, MG, Brazil) was used under irrigation with NaOCl 2,5% (ASFER, São Caetano do Sul, SP, Brazil) using 5 mL syringe (Ultradent, South Jordan, Utah, USA) and Navitip (Ultradent, South Jordan, Utah, USA). The AH Plus endodontic cement (Dentsply, Petrópolis, RJ, Brazil) and lateral condensation technique were used to obturation, keeping the apical portion of gutta-percha cone 1 mm from the radiographic apex.

Restorative procedures

The teeth were randomized using www.random.org in two groups (n=10) according to:

Group A: Glass ionomer (Maxxion R FGM, Joinville, SC, Brazil) was used for fill the pulp chamber floor in a 2.0mm layer using Centrix syringe. The occlusal restoration was done by incremental technique using a conventional composite resin (Opalis, FGM Produtos Odontológicos, Joinville, SC, Brazil) associated with selective phosphoric acid 37% (Fusion Duralink 37%, Angelus, Londrina, PR, Brazil) etching on enamel and the self-etching adhesive system (Clearfil SE Bond, Kuraray, Japan).

Group B: Bulk fill flowable composite resin (Opus Bulk Fill Flow, FGM, Joinville, SC, Brazil) was used for fill the pulp chamber floor in a 4mm and the occlusal restoration was filled using a conventional composite resin similarly to group A. All materials were light activated by using the VALO Cordless (Ultradent Products, South Jordan, UT, USA) light

curing unit that presented 1400mW/cm² checked by MARC resin calibrator (BlueLight, Halifax, Canadá).

Re-access of teeth

The teeth of each restorative protocol were randomized using www.random.org in two groups (n=5), depending on the method used to removal of the restoration: CHp, high-speed conventional handpiece (Kavo, Joinville, SC, Brazil) with 1.3 mm rounded diamond high length bur (#1013 HL, KG Sorensen, Cotia, SP, Brazil); and LEDHp: violet LED light high-speed (Ultra Vision Cobra LED, Gnatus, Ribeirão Preto, SP, Brazil) with same diamond bur. The removal of the restorative material was done until the gutta-percha in the root canal orifices been located. After this step, the samples were again stored in distilled water and all of them were rescanned in microCT.

Micro-CT analysis

To evaluate the intact dentin removal produced by re-intervention access cavity, the teeth from each group were scanned after restoration and after the re-access of teeth using a micro-CT device (SkyScan 1272, Bruker, Belgium) as previously described by Oliveira *et al*¹³. To standardize and allow superimposition of the images, the teeth were placed in the micro-CT in the same position with the buccal face facing the door. The image acquisition consuming approximately thirty-six minutes to scan each tooth using the following parameters: exposure time of 1800 milliseconds, energy 100 KV-100 µA, 180° rotation at the 0.700 step, Cu filter of 0.11 mm thickness, and a 15 µm voxel size.

The images acquired by micro-CT was imported to a computer and rebuilt using Nrecom software (version 1.6.10.1, SkyScan, Bruker, Belgium) in approximately 1.050 slices, respecting the anatomical limits of the samples. The reconstructed images were overlaid using DataViewer software (version 1.5.1.2, SkyScan, Bruker, Belgium). To align the different images of the restored and after the re-access of teeth, a reference point was selected that was distant from the area affected by wear. The volume of root and canals were used as a reference. The restored tooth image (reference) (Figure 1.C) and the tooth image (target) after endodontic re-access (Figure 1.E) were superimposed, this generated a volume of difference image (Diff) (Figure 1.F). This Diff image represented the volume of the dentin removal promoted for re-intervention access cavity. The micro-CT analyzer software (CTAn, version 1.13, SkyScan, Bruker, Belgium) was used to threshold the regions of interest, and to calculate the difference between the overlapping 2D images. The number of layers was the

same for all analyzed Diff images, at total of 800 layers, each with a resolution of 0.4 μ m. The regions of interest were positioned in the area of the pulp floor and cavity walls in the sample. The dentin removal volume values were obtained in mm³ and the percentage of was calculated as a function of the total volume of each tooth. Using the CT VOL software (CTVol, version 2.0, SkyScan, Bruker, Belgium), 3D images of the volume of the dentin removal were generated.

RESULTS

The scores of the dentin removal for different restorative protocols and method used for endodontic re-access are shown in Table 1. The microCT analysis showed no difference in dentin accidental removal on lateral or on the pulp chamber when violet light was or not used. However, when using glass ionomer for filling the base of pulp chamber the dentin removal was lower than when flowable bulk fill composite resin was used. The samples of the groups restored with glass ionomer had the tendency of the dentin accidentally removal predominantly in the surrounding walls in detriment to the floor, either using high-speed handpiece with white or UV light

DISCUSSION

Although the success rate of endodontic treatment is close to 90%¹⁴, even well-treated channels may fail.¹⁵ Endodontic re-treatment is the most recommended option in solving these failures. In clinical practice, there is a great demand for removal of restorative materials for endodontic retreatment. Keeping dentin integrity should be a primary goal when there is need for reopening for retreatment once the loss of dentin can result in fracture of the tooth after the final restoration¹⁶. Conservative cavities performed for root canal treatment is recommended for saving intact coronal structure^{17,18}. During the root canal re-access for re-treatment necessity significant amount of dentin laterally can be removed causing the loss of structural tooth integrity that might lead to a higher occurrence of fractures¹⁹. The use of micro-CT is an important non-destructive methodology that allows interpretations of the images before and after the technique²⁰. This study focused to analyze the accidental and undesired removal of dentin in two basic sites: 1 - surrounding walls of the coronary dentin generating weakening or possible coronary deviation during the root canal access; and 2 – on the floor of the pulp chamber that can have as main consequence the perforation and significantly affect the tooth prognosis.

For re-accessing the root canal is necessary to remove the coronal restoration and the material used for filling pulp chamber. The choice of the restorative material used for filling cavities in molars after endodontic treatment is determinant for avoiding dentin wear, in case of re-treatment necessity²¹. The use of flowable bulk fill composite resin to fill pulp chamber is easy for insertion reducing time and the bubbles formation²². However, the color similarity with root dentin may difficult the identification the exact limit of the restoration during removal process. This study showed that the use of the bulk fill flowable composite resin resulted in higher intact dentin removal during root canal re-access, regardless of the type of light used in the high-speed handpiece. Greater damage was verified on the floor, increasing the possibility of accidents such as perforation²³. In contrast, when the pulp chamber was filled using glass ionomer cement lower damage on the pulp floor was observed. Other aspect that contribute with this finding is the higher stiffness of the bulk fill flowable composite resin require more force applied during material removal, increasing the possibility of the undesirable contact of the bur with root dentin. The weakening of this structure or even the perforation is one of the main causes of failure of the endodontic therapy. On the other hand, removal of the ionomer from the floor of the chamber was facilitated by the better visualization of this material and also by its texture, and that in some cases, only the use of an exploratory probe with a straight and sharp tip was enough to remove the material of the walls in a very controlled way, which resulted in less dentin removal of the floor. This study demonstrated that using glass ionomer cement for fill the entrance of the root canal in molar teeth is recommended for reducing the dentin removal during re-access for root canal re-treatment. Additionally, previous study have demonstrated that the use of glass ionomer for filling pulp chamber reduce the shrinkage stress, the cusp deflexion and increased the fracture resistance of the ETT molar teeth²⁴.

This study tested also other study factor, additional illumination the area involved in the cavity preparation. Two LED lighting coupled to head of the handpiece were tested: violet light (UV) and white light (WL). The used of the violet light was tested aiming that the composite resin tested could be easier identified because the used composite resin used presented higher fluorescence. The violet light helped to identify the light during the initial removal because the light intensity is able to highlighted the fluorescence of the composite resin. However, the use of different light sources in high-speed handpiece had no benefit for identifying restorative material, especially from medium depth cavities. The obstruction of the field of view with high-speed handpiece head, as well as the angle of direction and consequent reflection of the light beam on the crown of the tooth, did not allow visualization

in deeper regions, having a small advantage for violet light) only in the delimitation of the point of choice, in the initial stage of occlusal reopening.

When dentin is unnecessarily removed, many negative consequences for the can appear. Extensive cavity preparation and endodontic access clearly reduce fracture resistance, and preservation of remaining coronal dentin should be a primary goal in preventing endodontically treated tooth fractures²⁵. It is known that the stiffness of the cusps significantly reduces when endodontic access involves the axial walls of dentin adjacent to each proximal cavity²⁶, and can weaken the tooth by up to 60%, when teeth with endodontic access and with axial walls, are compared with non-restored teeth²⁵.

The final shape of the access cavity is clinically relevant because a poorly performed access cavity may compromise the next steps of the treatment and still result in an increased risk of iatrogenic or treatment failure²⁷. Excesses of the composite resin was also verified on lateral the coronal and pulp chamber walls, creating the obstacle for endodontic files access making difficult the correct instrumentation. To avoid that situation its necessary a straight-line pathway into canals to enhance instrumentation efficacy and prevent procedural errors²⁸.

CONCLUSION

The use of glass ionomer cement for filling the base of the pulp chamber reduced the accidental dentin removal on the pulp chamber floor. The use handpiece with violet light presented had no advantage over white light for removal accidentally the dentin at lateral walls neither at the base of the pulp chamber dentin.

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Table 1. Micro-Ct analysis of dentin removal when using violet and white lighting during root canal re-access endodontic treated molars restored with bulk fill flowable resin or glass ionomer for filling pulp chamber.

Groups	Without Dentin removal		Dentin removal on lateral walls		Dentin removal on pulp floor wall		Dentin removal on lateral walls and on pulp floor wall	
	Violet Light	White Light	Violet Light	White Light	Violet Light	White Light	Violet Light	White Light
Bulk fill flowable / Conventional Composite Resin	-	-	2	2	1	-	-	1
Glass ionomer/ Conventional Composite Resin	-	-	3	3	-	-	-	-

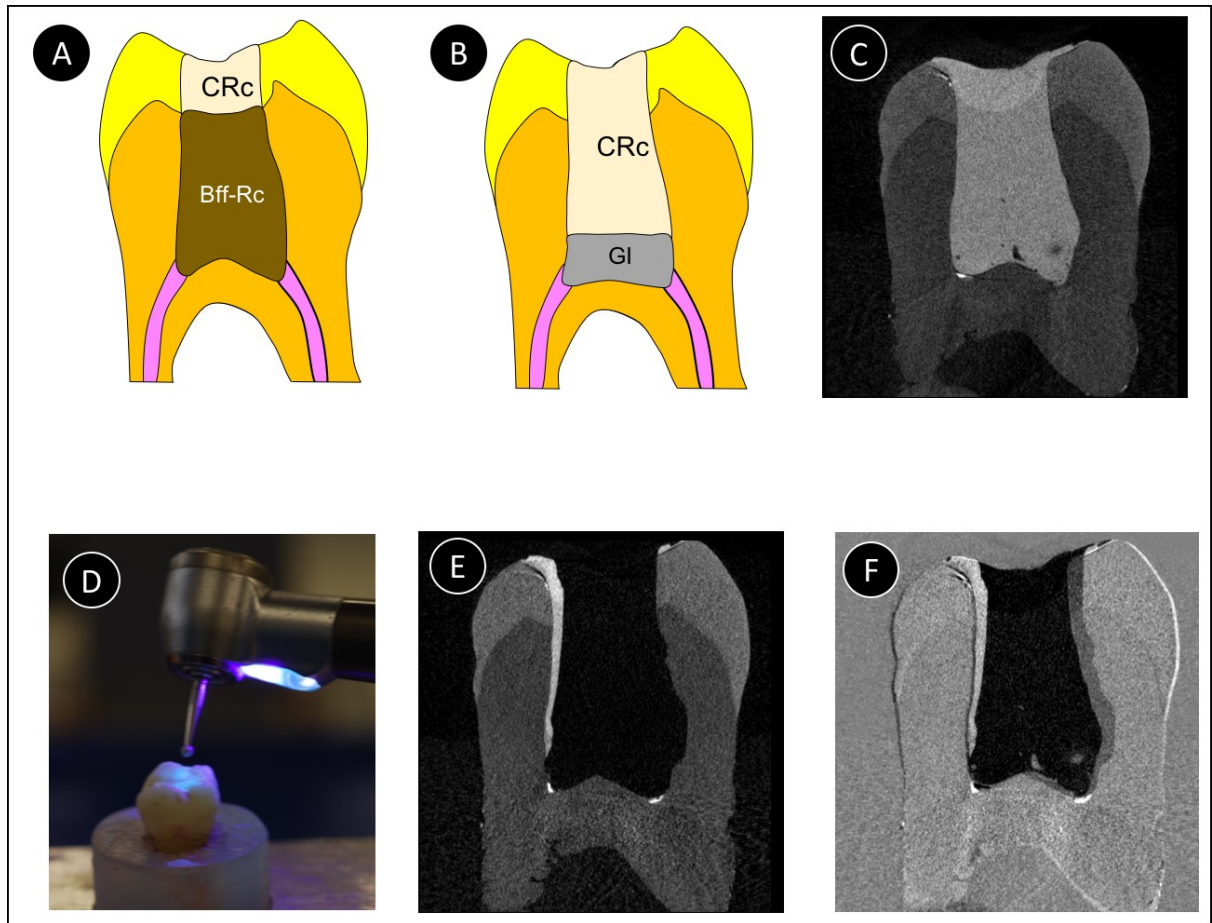


Fig 1. A. schematic illustration of bulk fill composite resin/conventional composite resin group; B. schematic illustration of Glass ionomer/conventional composite resin group; C. micro-Ct image of the sample after endodontic treatment and coronal restoration; D. handpiece with violet light during re-access opening; E. micro-Ct image of the sample after re-access opening; F. superposing micro-Ct images before and after re-access opening.

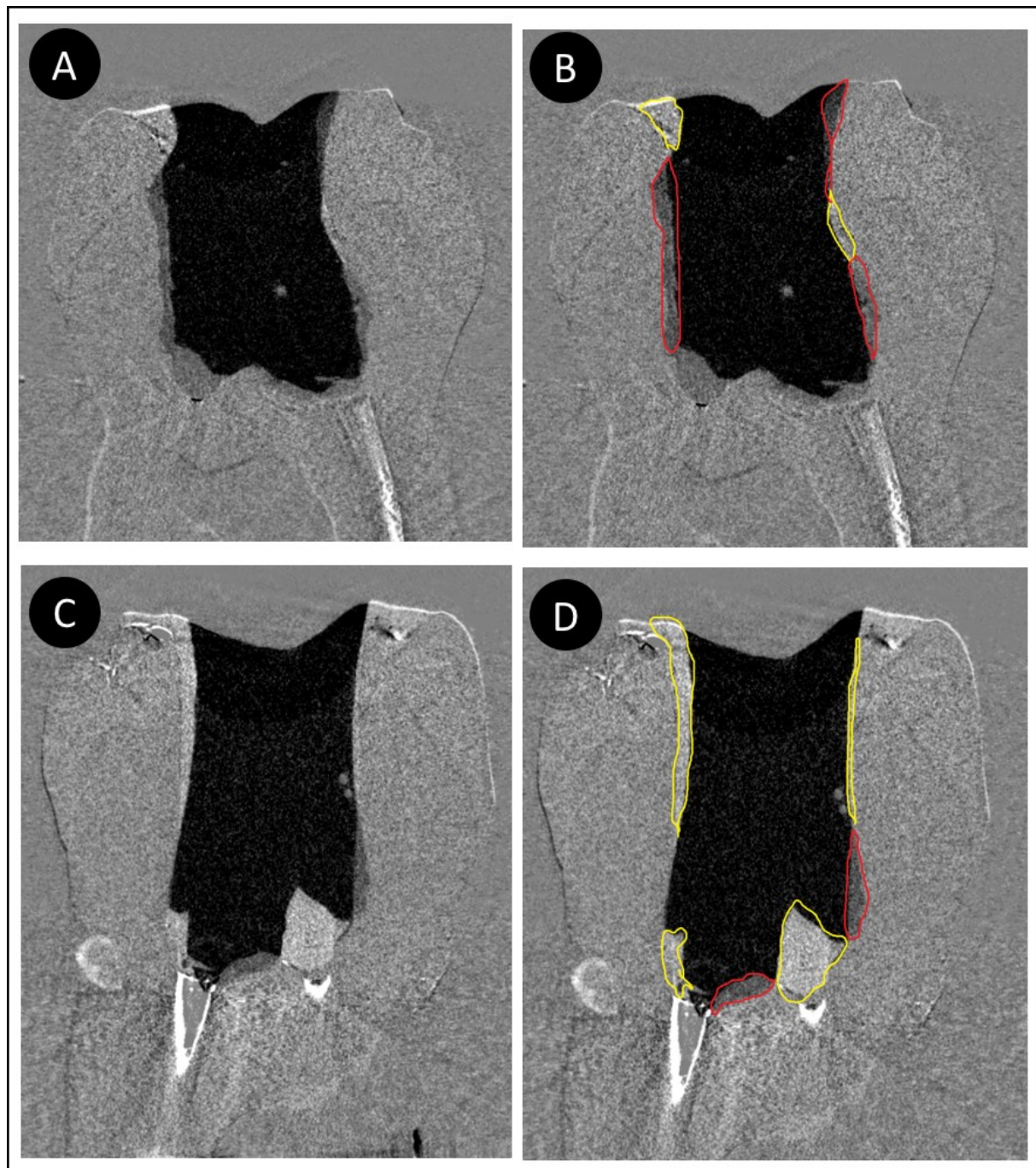


Fig. 2. Images of samples after cavity preparation and superposing for reconstruction and dentin removal identification. A. Glass ionomer/conventional composite resin group; B. areas delimited in red means dentin removal and areas delimited in yellow means composite resin excess; C. Bulk fill flowable composite resin/conventional composite resin group; D. areas delimited in red means dentin removal and areas delimited in yellow means composite resin excess.