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Undetected Microscopic Pulp Exposures in Deep Class II Cavities

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ABSTRACT Exposure of the pulp may act as a great insult during preparations, so this study investigated the probability of clinically undiagnosed pulp microexposures. The axial wall of 30 deep class II preparations in human premolars were searched for any microexposure after extraction. Seven teeth (23.7 percent) showed some kind of exposure. It is concluded that approximately 1/5 of class II preparations with the RDT less than 0.5 mm may have a pulpal microexposure.

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When the external cap of enamel or cementum is lost from the periphery of the dentinal tubules through caries or preparation with burs, the exposed tubules become conduits between the pulp and the external oral environment. Restored teeth are also at risk of toxic seepage through the phenomenon of microleakage between the restorative material and the cavity wall. Through capillary action, differential thermal expansion and diffusion, fluids containing various acidic, and bacterial products can penetrate the gap between tooth and restoration. [1,2] In fact, in many cases the most severe tissue trauma is not a direct result of caries, attrition or abrasion, instead, it results from the surgical techniques and materials used to restore tooth structure following these events.[3] The remaining dentinal thickness, RDT, is the key determinant of the diffusion gradient and serves as an excellent barrier to both pathological and iatrogenic insults.[1,2]

Evidence suggests that reduction in the RDT of cavity preparation increasingly make the pulp susceptible to traumatic injuries caused by cavity preparation and restoration events.[4] It is shown that the most important cavity variables in deep unexposed cavities for maintaining healthy pulp is remaining dentin thickness.[5]

The greatest insult to the pulp is in the case of the pulp exposure, which often goes undiagnosed.[2] Evidence showed a high degree of undiagnosed pulp exposures in patients with sign and symptoms of irreversible pulpitis.[6]

Knowledge of RDT and these undiagnosed pulp exposures allows the clini-

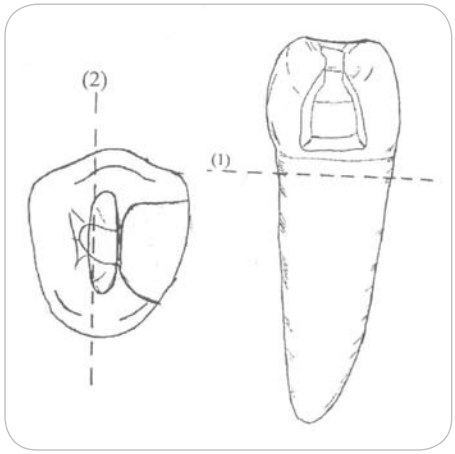

FIGURE 1. Schematic representation of the lines used for sectioning the teeth after extraction.

cian to undertake appropriate protective measures to limit pulpal damage. In the case of questionable prognosis for the future of the pulp, knowing that the remaining dentin thickness is minimal and an undiagnosed pulp exposure have occurred, could indicate a need for prophylactic endodontic therapy.[2]

Although, the pulp inflammation following surgery is largely uncharacterized, the advantage of the improved management of pulpal inflammation is that it may reduce the incidence of post operative pulpal complications. Furthermore, once the pulp becomes inflamed, it becomes hypersensitive so that thermal, mechanical or osmotic stimuli encountered in normal function can cause pain. Consequently, a more complete understanding of the relationship between pulpal inflammation and cavity restoration events may also lead to further improvement in clinical management of pain.[10] Some investigations have been performed on nonexposed cavities in human teeth.[7-10] These studies focused on the pulpal effects of restorative materials and other cavity variations in class V cavities. Although the importance of remaining dentinal thickness have been emphasized by previous studies to date, undiagnosed pulp exposure and remaining dentinal thickness have not been investigated.[5,8]

The aim of this study was to assess the undiagnosed pulp exposures in human deep class II preparations using light microscopy.

Methods and Materials

Thirty noncarious intact first or second maxillary premolars scheduled for extraction for orthodontic purposes were used. Patients were between the ages of 12 and 16. The proposal of the study was approved by the ethical committee of Yazd University of Medical Sciences. Informed consent was obtained from the parents of patients. After local anesthesia, two layers of matrix bands and a wooden wedge were inserted into the mesial embrasure of the tooth. (For optimum access and lightening only mesial cavities were prepared). Class II MO cavities with a wide buccolingual extension were then cut into the tooth using a dental handpiece with water spray coolant and diamond bur (835/008, Teez Kavan, Iran).

Next, the axial wall of preparation were deepened using a low-speed handpiece and round bur (C1, 204,021 Jota, Switzerland). Deepest cavity without any objective exposure or bleeding was prepared. In some cases, red shade of the pulp was seen. If any obvious exposure was seen, the case was excluded from the study. All the cavity preparations were prepared by one operator (author Majid Mousavinasab) and the teeth were immediately extracted and then the roots and the distal half of crowns were separated using low-speed diamond disks (D+Z, West Germany) (**FIGURE 1**).

Thereafter, the teeth were immersed in methylene blue 2 percent for 24 hours and after withdrawal, were washed under running tap water for complete removal of remnants of the dye. A light microscope (Olympus- CH30, Japan) was used for detection of any clinically undiagnosed pulpal exposures. Distal aspects of samples were settled over glass slide and the axial wall was explored for exposure spots. Any passage of the light through thin layer of dentin (bright spot in the dark field) was considered as an exposure. The minimum remaining dentin thickness of the axial wall was measured using a digital caliper (Mitutoyo-CD-8-CS, Japan) in four areas: near the buccal pulp horn, near the lingual pulp horn, with a one-mm distance from buccoaxiogingival point angle and with a one-mm distance from lingiaxiogingival line angle.

Results

Five teeth (16.6 percent) of all 30 samples showed one exposure spot (**FIGURE 2**), and two samples (6.6 percent) showed an area of cribriform exposure (**FIGURE 3**). Totally, seven teeth (23.3 percent) showed pulp exposure. None of the samples had two or more exposure spots. All seven exposures had been near the lingual or buccal pulp horns. Twenty-three remaining samples (76.7 percent) did not show any exposure (**FIGURE 4**). The average of remaining dentin thickness was 0.44±0.16 mm in the axial wall of the cavities. In the exposed teeth, the RDT was 0.27±0.02 mm and in unexposed teeth, it was 0.49±0.15.

Discussion

RDT underlying cavity preparations is one of the most important cavity factors in maintaining a healthy pulp.[5] RDT may be a surrogate for direct injury to odontoblast process, although it is thought that dentinal permeability also increases with decreasing RDT. Mature dentin is normally approximately 3 mm thick.[11] Over the years, the estimated value of the minimal cavity RDT, which does not cause pulp injury has been a topic of controversy.[7] RDT of 2 mm or more effectively preclude restorative damage to the pulp.[11]

Murray suggested that restoring cavity preparations, carefully cut down to 0.5

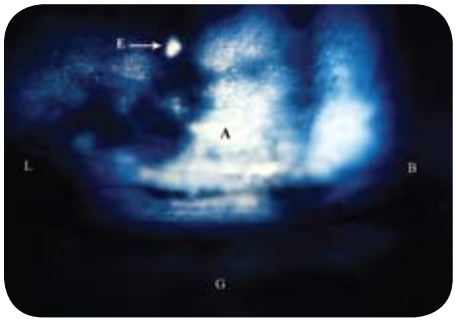

FIGURE 2. A sample showing an *exposure spot* (E) near the pulp horn. Darker areas around the picture are the areas with more RDT that does not permit the light to pass through. B: Buccal wall, L: Lingual wall, G: Gingival wall, A: Axial wall.

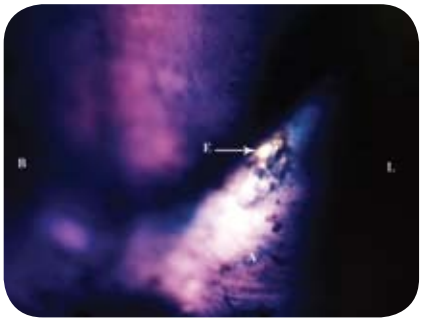

FIGURE 3. A sample showing a *cribriform exposure* (E) exactly on the pulp horn. Darker areas indicate more RDT. Because of different distances from the objective lens of the light microscope, other parts of the axial wall do not seem sharp. (Light microscope is only used to show the passing of the light after mechanical sectioning. In fact; none of the samples have received decalcification process). B: Buccal wall, L: Lingual wall, A: Axial wall.

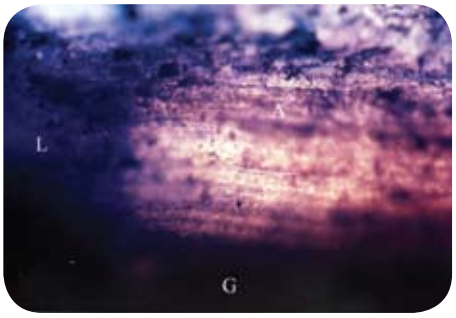

FIGURE 4. A sample without any exposure. There is no obvious microscopic exposure to permit the light to pass through the axial wall. If the distance change between the sample and the objective lens, sharp areas may become dull and dull areas may become sharp. L: Lingual wall, G: Gingival wall, A: Axial wall.

mm, with zinc oxide eugenol, ZOE, intermediate restorative material, IRM, and calcium hydroxide ($Ca(OH)_2$)/amalgam, appeared to have little effect on underlying odontoblast numbers for up to 381 days following treatment in patients.[12]

Deeper cutting (less than .3 mm from the pulp) results in direct odontoblast injury.[11] During cavity preparation the greatest insult to the pulp is in the case of pulp exposure, which often goes undiagnosed.[2] Microbes rapidly reach the surface of the pulp after direct exposure from restorative procedures.[13] Pulpal exposure can promote pulpal edema by evoking an acute inflammatory response and by virtue of the mechanical opening. The development of pulpal edema can have several deleterious effects including extrusion of pulpal tissue, dislodgment of pulp capping materials, loss of an effective seal against bacterial invasion, development of a chronic inflammatory infiltrate, and inhibition of tertiary dentinal formation.[14]

Pashley regarded a RDT of 0.5 mm as a functional exposure and the importance of exposure of the pulp cannot be neglected.[15] Seltzer et al. showed a high degree of undiagnosed pulp exposures in patients with sign and symptoms of irreversible pulpitis.[6] Although some investigators have focused on ultrasonic devices for determining RDT, it seems that it is not an easy or practical method for clinicians.[2]

In the present study, 30 deep class II cavities were prepared in premolars. The mean RDT of the cavities was 0.44±0.16 mm. In Camps' study, only 22 percent of the 317 class V cavities had remaining dentin thickness less than 500 µm.[8] In the other study, 32 of 66 class V cavities had RDT less than 0.5 mm.[7] In yet another study of the authors, the mean RDT of 55 class V cavities was 0.68±.19 mm and 34 percent of the samples had RDT less than 0.5 mm.[9]

Cavities in the present study had less RDT than the previous studies. It seems that the type of preparations (class V or class II) and the difference in operator abilities determine the remaining dentin thickness in such studies.

Ten samples (approximately 10 percent) in the Murray study were exposed, while 23 percent of teeth in the authors' study showed exposure spots.[8] This is due to the type of preparations and method of finding the exposure spots. Determining of RDT and exposure in Murray study was performed using histological sections through experimental area of teeth that may have missed the exposure spots.

In the present study, the direct inspection method was used for detection of the exposures. Furthermore, the probability of exposure near the pulp horns in class II preparations may be more than class V cavities.

Reduction in the RDT of cavity preparations increasingly make the pulp susceptible to traumatic injuries caused by cavity preparation and restoration events.[8] Thus, it is important to avoid needless dentin removal during cavity preparation. Nevertheless, often the RDT of cavity preparations will be determined by the extent of disease progression and treatment regimen.[8]

According to this study, approximately 20 percent of class II cavities with the RDT less than 0.5 mm may have one undiagnosed exposure spot. Thus, in these cases direct pulp capping protocol, including irrigation of the cavity and calcium hydroxide application, should be precisely performed or a prophylactic endodontic treatment should be considered.

Conclusions

Extremely deep preparations with RDT less than 0.5 mm in the axial wall may have a clinically undiagnosed pulp microexposure. These exposures do not have any bleeding and cannot be seen by the operators. According to the findings of this study, exposure may happen in approximately one-fifth of the extremely deep class II cavities. Therefore, the precise direct pulp capping, including irrigating the cavity and calcium hydroxide application or a prophylactic endodontic treatment, should be considered. ■■■■

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