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Literature review of the relationship between secondary caries and the restoration gap size

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Abstract

Objective: To assess the effect that the size of the gap between the tooth and composite interfaces plays in the growth of the secondary carious lesion.

Methods: The articles found on MEDLINE®/Pubmed using an electronic search were restricted to January 2014 to May 2024. The evaluated sample size fell between 0 μm and 1.025 μm.

Results: The gap size of 66 μm might result in the development of secondary caries when the risk of caries is high.

Conclusion: According to the results of our literature study, secondary caries is more likely to occur the bigger the gap between the tooth and the resin composite restoration material, unless the caries risk is minimal and fluoride treatment is not used. The precise gap size threshold at which potential decay can occur is a topic of debate. Consequently, further research will be required in the future.

Keywords: Secondary caries; Gap size; Restoration; Microleakage.

Introduction

In recent years, composite restorations have become popular over more conventional materials like amalgam because of their enhanced aesthetics, preparations that spare the tooth, corrosion resistance, and other factors. Nonetheless, gaps may emerge at the tooth-restoration interface due to composites' natural polymerization shrinkage [1].

Resin-based composites are considered the gold standard for restorative dentistry because of their unique properties. Dentists anticipate a composite material with excellent marginal integrity, little polymerization shrinkage, great aesthetic value, and pertinent physico-mechanical qualities from

contemporary technology. In posterior teeth, embedding a composite repair often takes a lot of time. Filling large cavities in the back teeth may include introducing particles or air bubbles between the composite layers [2]. In vitro studies have linked the occurrence of secondary caries to microleakage, and microleakage has a substantial correlation with the marginal gap. This creation of gaps might lead to secondary caries [3,4]. The primary cause of dental composite restorations' long-term failure, particularly in individuals with high caries risk, is attributed to secondary caries [5].

One of three possible outcomes for secondary caries is as follows: (1) it can be causally linked to a defective restoration (primarily through gaps that allow acidic fluids or biofilm to enter the interface); (2) it can be causally linked to an intact restoration (for example, by the restoration's lower buffering capacity relative to the tooth's hard tissue); or (3) It can only be primary caries close to existing restorations, especially if the patient's caries process has not received enough attention and the restoration's tooth surface becomes carious as a result of the current caries activity [6]. But in all three situations, the established elements necessary for the formation of caries-the existence of the cariogenic biofilm, there needs to be a balance in the loss of minerals, the availability of fermentable carbohydrates, and the loss of tooth-hard tissue. These many pathogenic pathways may lead to demineralization at the interface with the surface and this is called wall lesion, as well as on the tooth surface, as is usually the case in primary carious lesions [6].

Microleakage is one of the most prevalent problems with resin composites. When there is insufficient sealing, a marginal gap might appear at the interface of the tooth restoration. When the pressures from polymerization are greater than the bond strength, microleakage can occur at the interface between the tooth restoration and the tooth. These strains are generated both within and outside the restoration [7]. Previous investigations have revealed that one significant component linked to interfacial mineral loss is the gap size itself. Larger gaps may not restrict the diffusion and hence result in higher mineral loss of the wall lesions, whereas tiny gaps can inhibit the speed of defect formation due to the transfer of acid into and dissolving product out of the gap [5,8]. Gaps might arise from improper repair placement at first, such as from non-compensated polymerization shrinkage or inadequate light-curing of the material (which would then need washing off the uncured components). Hydrolytic deterioration of the hybrid layer and, consequently, the interface in the case of adhesive (resin-based) restorations can also result in long-term flaws and gaps [5,9].

Methods

The articles found on MEDLINE®/Pubmed using an electronic search were restricted to January 2014 to May 2024. The terms "Gap Size" and "Secondary Caries or Caries" were chosen and examined following the goals. Included were just those papers that suggested using composite materials in studies. Twelve publications were found once the inclusion criteria were applied to the search. These investigations used occlusal splints holding human dentin samples or tooth-resin composite specimens to examine gap size or secondary caries close to restorations. The evaluated sample size fell between 0 μm and 1.025 μm.

Results

The majority of research concluded that, as long as there is fluoride release and a minimal caries risk, gap size has no impact on the development of secondary decay. Even a gap size of 66 μm might result in the development of secondary caries when the risk of caries is high. Nonetheless, there was general agreement that the growth of the dentin wall at the tooth-resin composite interface might be caused by the high enamel gap size, which ranges from 100 μm to 600 μm.

Discussion

The primary cause for replacing amalgam and composite resin restorations is secondary caries. Microleakage, brought about by a tiny space between the tooth-restoration surfaces, is one of the potential etiologic factors for developing secondary caries surrounding resin composite restorations. Nevertheless, researchers Jorgensen and Wakumoto discovered that if the gap size at the tooth-restoration contact is kept between 35 and 50 μm, secondary caries would not develop; as a result, microleakage will not cause secondary caries [10]. Even in this standardized in situ model, the advancement of the secondary caries wall lesion seems to be connected to individual characteristics. Very tiny gaps around or bigger than 30 μm form secondary caries regardless of the patient's caries activity level [11].

Although a threshold for the minimum gap size in which wall lesions might occur was still unknown, many investigations revealed that secondary caries lesions could develop in smaller gaps than previously believed. Wall lesions were identified in gaps with a width of around 70 μm. Should a threshold of this kind exist, it is most likely located within the range of around 10-70 μm. Therefore, the purpose of this in vitro investigation was to assess the development of dentin wall lesions next to resin composite in extremely tiny gap sizes and to determine if it would be possible to create a meaningful threshold for the gap size [11-14]. According to Kuper et al. even a gap size of 68 μm may result in the development of secondary caries when the risk of caries is high. However, in cases when the risk of caries is low, the gap size may not matter. This might suggest that the minimum gap size for secondary caries development can be less than what has been previously reported in the literature (>250 μm) [13].

Other research found that even bigger gaps, between 250 and 400 μm, do not affect the development of secondary caries [10]. The study using transversal microradiography and confocal laser scanning microscopy, gap diameters, and secondary caries development were examined. In enamel, the median gap size was 9.4 μm, interquartile range: of 7.9-12.7 [15].

Although, Kuper et al. concluded that, in terms of clinical outcomes, the patient's caries sensitivity may outweigh the impact of gap size on the emergence of secondary caries. Nonetheless, it is evident that the gap that forms between the tooth and the resin composite, in addition to other significant variables, creates an environment that is conducive to the development of secondary caries [13]. The study reported It appears that the restorative material has little influence on subsequent caries. Other variables that are more significant include the quantity and existence of restoration gaps, a patient's caries risk, and the operator's expertise. The secondary caries detection techniques used today have little validation and may

overidentify cases. It could be wise to employ particular techniques, particularly in low-risk groups. To prolong the life of the restoration, detected secondary caries can be replaced or, if partially deficient, also taken into consideration for repair or resealing [5]. The study evaluated visual and scanner evaluations were correlated using Spearman's correlation with the reference standard. The gap measured and evaluated by visual inspection and the gap assessed by the scanner underwent separate Spearman's rank correlation assessments. stated that when it comes to gap size measurement, the eye inspection performs better than the 3D intraoral scanner [16].

There is a tendency that indicates a higher chance of acquiring secondary caries as the gap size rises, however, an exact threshold for developing secondary caries cannot be determined at this time based on the research included in this literature review.

Conclusion

According to the results of our literature study, secondary caries is more likely to occur the bigger the gap between the tooth and the resin composite restoration material, unless the caries risk is minimal and fluoride treatment is not used. The precise gap size threshold at which potential decay can occur is a topic of debate. Consequently, further research will be required in the future.

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