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Review Article

# Wear of resin composites: Current insights into underlying mechanisms, evaluation methods and influential factors<sup>☆</sup>

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**Summary** The application of resin composites in dentistry has become increasingly widespread due to the increased aesthetic demands of patients, improvements in the formulation of resin composites, and the ability of these materials to bond to tooth structures, together with concerns about dental amalgam fillings. As resistance to wear is an important factor in determining the clinical success of resin composite restoratives, this review article defines what constitutes wear and describes the major underlying phenomena involved in this process. Insights are further included on both *in vivo* and *in vitro* tests used to determine the wear resistance of resin composite and the relationships between these tests. The discussion focuses on factors that contribute to the wear of resin composite. Finally, future perspectives are included on both clinical and laboratory tests and on the development of resin composite restorations.

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1. Introduction

The use of resin composites restorations in posterior teeth is increasing worldwide due to improvements in their mechanical properties [1]. An extensive database maintained by the Washington Dental Service in the U.S. reveals that the use of resin composite restorations in posterior teeth only surpassed that of amalgams in 1999 [2]. Among the reason for the switch from amalgam to resin composites might be the desire for restorations that match the color of the tooth and the increasing familiarity and comfort of clinicians with the use of resin composites [3]. In addition, early clinical studies of resin composite restorations in posterior teeth by Wilson et al. [4–7] in the late 1980s and by Stangel et al. [8,9] in 1990 reported a probability of success similar to that of amalgam, which might have encouraged the use of these restorations.

The increased use of resin composite restorations in posterior teeth has driven ongoing efforts to improve their clinical performance [10]. Alvanforoush et al. [11] stated that although the overall rates of clinical failure of resin composite restorations in posterior teeth showed little difference between 1995–2005 and 2006–2016, the causes of the failure showed a notable change, with wear becoming more important due to the increasing numbers of resin composite restorations in posterior teeth. Other systematic reviews have shown that the wear of resin composites is one of the reasons for fractures found in restorations in posterior teeth [12,13]. Resin composite restorations in posterior teeth are subjected to a wide range of mechanical forces and chemical effects, such as food chewing and unconscious bruxism [14–16]. If the forces applied to the resin composite restorations exceed the mechanical strength of the material wear may occur which is particularly likely to happen in patients who apply greater than average forces during mastication [17]. These occlusal forces may also cause roughening

of the surfaces, leading them to lose their shape [18]. Thus, the wear resistance of a resin composite is central to the long-term stability of restorations.

In 1998, Söderholm and Richards [19] published “Wear resistance of composites: a solved problem?” and concluded as follows: “Based on some clinical data, we can conclude that under some conditions, occlusal wear of posterior resin composites restoration remains a clinical problem, although not as bad as it was 10 years ago”. In 2006, Ferracane [20] re-evaluated the same topic and asked “Is the wear of dental composites still a clinical concern? Is there still a need for *in vitro* wear simulating devices?” He concluded that “While the wear resistance of dental composite restoratives is no longer considered to be a major concern for most restorations, the relatively limited information available suggests that it may still be a concern for very large restorations in direct occlusal contact, or for those patients with bruxing and clenching behavior.”

A PubMed literature search in English for “resin composites” in August 2017 shows that almost 10,000 articles have been published on this topic in the past 10 years (2008–2017). In this period, the number of articles published on “resin composite and wear” was 447 and “resin composite and abrasion” was 365. If the wear of resin composite is no longer of a concern, one must question why so many researchers continue to devote so much time to studying it. Therefore, it is perhaps useful to raise the question again: “Is the wear of resin composite restorations still a clinical concern?”

Based on the amount of resin composite sold, it is estimated that around 800 million resin composite restorations were placed worldwide in 2015 alone; with about 80% placed in the posterior region and 20% in the anterior region [21]. A meta-analysis of resin composite restorations in posterior teeth has shown that at least 5% of them failed due to fracture of the material and about 12% showed noticeable wear

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