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Review

Microleakage after thermocycling of cemented crowns—A meta-analysis

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ABSTRACT

Objectives. Microleakage testing of dental materials is a commonly accepted evaluation technique of margin integrity. Thermocycling has been utilized by many researchers to study the influence of temperature extremes on the marginal gap of cemented restorations. The aim of this investigation was to analyze microleakage data on cemented crowns, published in the dental literature until Dec 2009, to identify methodological factors that might potentially affect the results of *in vitro* microleakage tests and to compare the results.

Methods. The following databases were included: Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1950 to Present, Ovid-MEDLINE(R) 1950 to Present with Daily Update, EMBASE, EBM Reviews – Cochrane Database of Systematic Reviews and Pub Med. The search was limited to articles in English, French, Italian and German published until the end of 2009. Classical reviews, comments, animal studies, *in vivo* articles and studies investigating restorative materials or milk teeth were excluded. 33 different studies were finally selected. The studies were entered in a database and compared using selected literature criteria: sample, restoration procedures, thermocycling and mechanical cycling, evaluation method. For statistical analysis only 16 studies could be applied.

Results. It was not possible to make a quantitative synthesis of most of the data, due to the heterogeneity of the studies concerning methods, treatment and outcome variables. Comparing the main groups of materials (ceramics, gold alloys and base metal alloys), no significant difference in the proportion of teeth without microleakage was found. Furthermore no significant difference in the proportion of teeth showing microleakage less than two third of the wall or teeth showing microleakage including the entire wall was found. Using the mean values in the meta-analysis instead of the proportions does not change the results. Confidence intervals could only be calculated for two materials (gold alloy, metal alloy). No difference between materials was found.

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Significance. Comparison of the results from different studies is critical, since there are no generally accepted standards for experimental parameters, such as type and concentration of the storage solution, time of storage, temperature during storage, type and duration of thermal cycling and/or mechanical cycling, and the scoring criteria. There is lack of standardization of experimental conditions, which would ensure confidence in the studies and would further allow better comparability of various results.

Contents

1. Introduction

Exposure of restorations in extracted teeth to cyclic thermal fluctuations to simulate one of the many factors in the oral environment has been common in many tracer penetration, marginal gap and bond strength laboratory investigations.

Dental cements are used for the anchoring of indirectly prepared cast restorations and are thought to fill and lute the marginal gaps between teeth and machined restorations. The minimum width of the marginal gaps ideally corresponds to the minimum cement layer thickness. Marginal adaption is one of the important criteria used in the clinical evaluation of fixed restorations. A well-fitting restoration reduces the chance for recurrent caries and periodontal disease, whereas the space between a poorly fitting restoration and tooth preparation enables accumulation of bacterial plaque. The presence of marginal discrepancies in the cemented restoration exposes the luting agent to the oral environment. Larger marginal discrepancy and subsequent exposure of the dental luting agent to oral fluids enhance the risk of cement dissolution. Such dissolution in turn can promote shrinkage and microleakage, caused by a lack of adhesion between luting agent and tooth structure on one side and luting agent and restoration on the other side. Mechanical failure of the luting agent can be the consequence. Accordingly, small marginal gaps will minimize plaque accumulation and subsequent disease and will thus protect the luting agents from the oral environment and mechanical forces. Caries as well as crown dislodgment are the most common reasons for failure of indirect restorations: several laboratory fatigue studies have shown that cement microfractures are typically the initial mode of failure [1] that is followed either by dislodgment of the restoration or even by tooth fracture. Clinical studies also have shown that poor marginal adaption of a restoration correlates with increased plaque retention and reduced gingival health [2,3], as indicated by a higher Plaque Index (PI), an elevated Gingival Index (GI), and increased pocket depths (PD). Also changes in the subgingival microflora can be attributed to inadequate marginal fitting.

Microleakage is defined as the movement of fluids carrying bacteria and other molecules and ions at the boundary between a restoration and a tooth [4]. Although it is difficult to detect clinically, microleakage is considered to be a major factor influencing the longevity of dental restorations since it may, for instance, lead to staining at the margins of the fillings, hastening damage of the restorations at the marginal areas, recurrent caries at the tooth/restoration interface, hypersensitivity of restored teeth, or development of pulpal pathology. Factors involved in the formation of marginal gaps and subsequent leakage between the cavity wall and restoration include besides operator errors also temperature variations, inadequate moisture control leading to moisture absorption and polymerization shrinkage, as well as masticatory forces. Hygroscopic absorption, i.e. water uptake by the restorative material and incremental insertion of restorative materials can partially compensate for these inadequacies [5–7]. However, microgaps formed at the margins facilitate bacterial ingress precipitating staining and hence discoloration, defective restorations, postoperative sensitivity, chronic hypersensitivity, secondary caries, and possible pulpal pathosis.

Different methods have been employed to evaluate microleakage around restorations *in vivo* and *in vitro*. The latter, i.e. *in vitro* microleakage testing of dental materials, is a commonly accepted evaluation technique of margin integrity. Although clinical relevance of *in vitro* leakage tests does not always correlate with the current clinical situation these tests are the most frequently used laboratory examinations to study