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Review

Treatment of proximal caries lesions by tunnel restorations

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ABSTRACT

Objective. The "tunnel technique" may be used as an alternative to the "conventional" class II preparation for the treatment of proximal dentin caries. The purpose of this article was to summarize and discuss the available information concerning the tunnel technique and the clinical success of tunnel restorations.

Methods. Information from original scientific full papers or reviews listed in PubMed (search term: tunnel preparation or tunnel restoration) were included in the review. Papers dealing with endodontic or periodontal topics and case reports were not taken into consideration. Clinical studies were included when at least 20 restorations could be followed-up for at least 24 months. In vivo- and in vitro-studies were excluded when the number of restorations under observation or the decision criteria were not clearly defined. Insufficient data about tunnel restorations in the primary dentition do not allow for analysis.

Results. Both effectiveness of caries removal and marginal ridge strength are reduced in tunnel restorations compared to conventional class II. Glass-ionomer tunnel restorations exhibit an annual failure rate of 7–10%. Therefore, the main reasons for clinical failure are marginal ridge fracture, recurrent caries and progression of demineralization. However, clinical studies indicate that composite but not glass-ionomer tunnel restorations might be a promising alternative.

Conclusion. Tunnel restorations filled with glass-ionomer cements exhibit technical deficiencies and a limited life-span compared to conventional class II composite or amalgam restorations and could not be recommended as an alternative preparation for proximal carious lesions. Promising clinical results of composite tunnel restorations need to be confirmed by long-term studies.

Contents

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1. Introduction

For proximal dentin lesions requiring operative interventions both 'tunnel' cavities and 'slot' or 'box-only' preparations are recommended [1]. Occasionally, a proximal access to the caries can be achieved when the adjacent tooth is missing (e.g. at time of tooth eruption) or when the proximal surface becomes accessible at the time of cavity preparation of the adjacent tooth.

'Tunnel restorations' were first described in 1963 [2] and gained increasing popularity since reported by Knight [3] and Hunt [4]. According to its original definition, the tunnel preparation accesses proximal dentinal caries through an occlusal pit and is designed to preserve the overlying proximal marginal ridge and maintain greater tooth integrity. Concerning the preparation technique, preparations are mostly classified as 'total tunnels' when the proximal enamel is perforated and removed and as 'partial tunnels' in case of not-perforated proximal enamel [5–10]. As an alternative, tunnel preparations can be classified in three techniques: (1) total removal of the demineralized proximal enamel ('total tunnel'), (2) extension onto the proximal surface only by a small perforation leaving some demineralized enamel adjacent to the restoration ('partial tunnel') and (3) removal of the dentin caries while preserving the proximal enamel completely ('internal approach') [11]. While the classification of most studies follows the first definition, tunnel preparations in the present review were described both as cavities with enamel perforation ('total tunnel') and cavities without perforation of the proximal surface ('partial tunnel').

As an alternative to tunnel preparations, proximal caries can be opened by the preparation of a small box or slot through the marginal ridge which allows for direct inspection of the cavity during caries excavation. This preparation is extended to only that tooth structure which has completely broken down with no possibility of remineralization.

Surveys about preparation techniques of proximal carious lesions found that 47–48% of dentists prefer tunnel restorations, while 24–32% choose saucer-shaped preparations and 20–28% traditional class II preparation [12,13]. However, even though most dentists would prefer tunnel restorations for maximal preservation of sound tooth structure, this technique is regarded to be associated with incomplete caries removal, an increased risk of marginal ridge fracture or poor adaptation of the restoration proximally.

Therefore, the aim of the present review was to summarize and discuss the currently available information about tunnel restorations and to compare the clinical success of tunnel restorations with alternative techniques, such as slot preparation or traditional class II cavities.

2. Methods

All original scientific full papers or reviews listed in PubMed (search term: tunnel preparation or tunnel restoration) were included in the review. Papers dealing with endodontic or periodontal topics and case reports were not taken into consideration. Clinical or laboratory studies were excluded when the number of restorations under observation or the decision criteria were not clearly defined. Furthermore, clinical trials were only taken into consideration, when at least 20 restorations were followed-up for at least 24 months. For ensuring appropriate conclusions from the available data, clinical trials were only included when decision criteria for examination were clearly defined and allow for classification of failure. Thereby, tunnel restorations exhibiting marginal fracture, recurrent caries or caries progression or being replaced due to caries or marginal ridge fracture were classified as failure. However, only four studies (Table 1) were designed as clinical trials including a control [14–17]. The inclusion of a control is important to allow for comparison between tunnel restorations and conventional fillings. Due to the limited data from the randomized control trials, clinical success of tunnel restorations was also compared to the results of a recent systematic review on the longevity of direct and indirect restorations in posterior teeth [18].

Most studies for tunnel restorations in primary teeth failed the inclusion criteria. Only one study could be included but found only 10% of glass-ionomer tunnel restorations to be acceptable after 3 years [7]. Due to the limited data, validated conclusions about tunnel restorations in the primary dentition are currently not possible.

3. Results

3.1. *Tunnel technique and effectiveness of caries removal*

The tunnel preparation intends to leave the marginal ridge intact by proceeding diagonally from the occlusal surface to the proximal carious lesion. The access is recommended to be at least a distance of 2 mm from the marginal ridge. Generally, effectiveness of caries removal increases with increasing size of the occlusal opening due to better visibility [19,20]. It could be shown that the quality of caries excavation in tunnel cavities is improved as the access is placed nearer to the marginal ridge [21]. On the other hand, increasing the size of the tunnel preparation might enhance the risk of removing sound dental hard tissue. Moreover, an occlusal opening which is placed nearer to the marginal ridge may increase the risk of marginal ridge fracture [22]. However, with access close to the marginal ridge less tooth substance might be removed since the cavity