Adhesive Resin Aiming for Dentin Regeneration

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Abstract:The concept of minimal intervention dentistry has evolved as a consequence of our increased understanding of the caries process and the development of adhesive restorative materials. Recently, new concepts of treatments for dentin caries by use adhesive resins and glass-ionomer cements have been proposed. However, new hard tissue, indicated as the result of applying calcium hydroxide or adhesive resins and/or sterilized by the mixed drugs, formed with a tunnel defect frequency present, running from the medicament interface to pulp. These reports suggest the urgent necessity for us to the establishment of the biological dentin regeneration therapy like the Modified Sealed Restoration (MSR). In this review, we reported "In vivo dentin regeneration by adhesive resin containing EVA+C" and "Future approaches to establish the dentin regeneration therapy".

Key words: sealed restoration, resin adhesion, dentin regeneration, EVA+C

Introduction

Recently, new concepts of treatments for dentin caries by use of adhesive resins and glass-ionomer cements have been proposed. Table 1 summarizes the new tendency of treatments for dentin caries, and dramatic changes of the roles of adhesive dentistry have occurred from the end of the 20th century. From the mainly reparative dentistry in 20th century, contemporary dentistry shins towards a minimal intervention (Ml) approach, and contemporary operative treatment incorporates the Ml philosophy in cavity design[1]. Especially, hybridized dentin permits dental treatments that were previously impossible with conventional techniques, opening new previously impossible with conventional technique, opening new frontiers in modern adverted dentistry[2].

Traditional treatment of carious teeth involves removal of all carious tooth structure prior to placement of the restorative materials, often sacrificing more structure than necessary. Handelman et al. proposed using resin sealants to seal carious pits and fissures following acid-etching[3]. The careful work of Handelman and his colleagues demonstrated that the residual bacteria became dormant and much less viable[4]. This work was followed by a ten year clinical trial by Mertz-Fairhurst et al[5]. They radiographically selected lesions that were beyond the EDJ but no more than half-way to the pulp. The enamel was beveled and no carious dentin was removed. After acid-etching, they p[aced a chemically-cured radiopaque posterior resin composite (Fig.1). They showed no radiographic progression of the lesions and few viable microorganisms when the resin-Sealed lesions were biopsied years after placing resin composites, but further progression of caries in untreated teeth. Their studies were done with relatively old materials rather than with more hydrophilic contemporary adhesive formulations. If residual bacteria in caries-infected dentin can be embedded by adhesive resins, and if these embedded bacteria become dormant, even caries-infected dentin may be conserved without progression of the caries process. We have proposed this concept as "Modified sealed restoration" (MSR) as shown in Figure 2. Moreover, if remineralization of caries-infected demineralized dentin is occurred after MSR with an antibacterial fluoride-releasing adhesive system, we may establish the ultra-conservative therapy of caries-infected dentin (Fig.3).

Recently, exciting biomimetic and tissue engineering approaches to develop the dentin regeneration therapy (DRT). These might include growth factor, gene or stem cell therapy (Fig.4). We have focused on collagen-immobillized ethylene-co-vinyl alcohol (EVA+C, The Nippon Synthetic Chemical Industry, Japan) to the differentiation of pulp cells into odontblasts.

In vivo dentin regeneration by adhesive resin containing EVA+C

We have examined the biocompatibility of an experimental adhesive system containing EVA+C (EVA+C bioprimer) to cultured human pulpal cells, and the results suggest that EVA+C bioprimer shows a very good biocompatibility to these cells in vitro. Moreover, we have cut the exposed cavities in the anterior

Table 1 New tendency of treatment for dentin caries

ART	Atraumatic restorative technique
IPC	Indirect pulp capping
LSTR	Lesion sterilization and tissue regeneration
MI	Minimal intervention
MSR	Modified sealed restoration
DRT	Dentin regeneration therapy

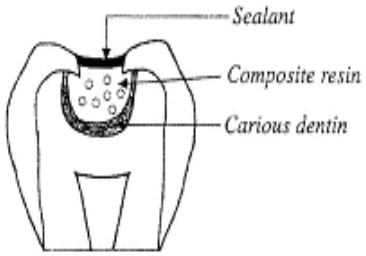

Fig.1

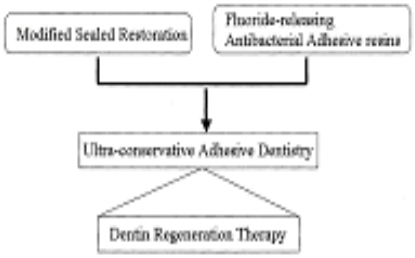

Fig.2

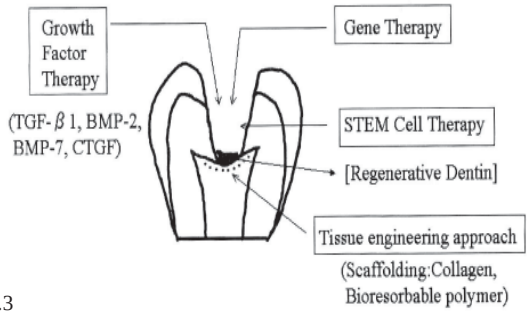

Fig.3

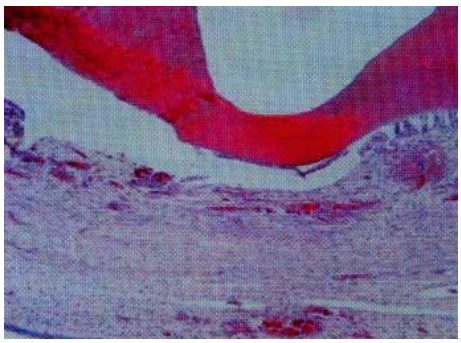

Fig.4

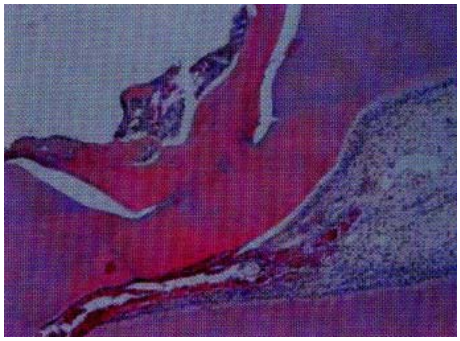

Fig.5

teeth of the monkey under the general anesthesia, and applied the EVA+C bioprimer to the pulp-exposed surface and filled the cavity with a commercial composite resin. After 3 months, we have extracted the filled tooth from the monkey,- and observed the condition of regenerative dentin at the exposed pulp by a right microscopy after the EDTA demineralization of the teeth. Figure 5 shows the thinner regenerative dentin on the exposed pulp without EVA+C bioprimer as a control, and Figure 6 shows the thicker regenerative dentin formation on the exposed pulp with EVA+C bioprimer (Patent has been applied).

The mean thickness of the regenerative dentin with EVA+C was 618ìm, and that without EVA+C was 357ìm. There was a significant difference between the thicknesses of both teeth. Pulpal inflammation was observed in the teeth filled with EVA+C bioprimer.

These results were obtained from the limited in vivo an1'mal study, however suggested that EVA+C bioprimer may promote the regeneration of dentin not only in the pulp chamber but also onto the exposed surface. This study is kindly supported by a Grant-in-Aid (B) (2) (No.15390576) for Scientific Research from the Ministry of Education, Culture, Sports. Science and Technology, Japan.

Future approaches to establish the dentin regeneration therapy

All of these approaches require careful consideration of the processes taking place if repair and regeneration are to be achieved in a controlled manner. While delivery of these agents provides one hurdle to be overcome, a greater challenge will be the regulation of their effects if total obliteration of the pulp chamber by the repair process is to be avoided[6]. A number of other considerations will also require attention, including those of ethical and immunogenical nature. A perfect understanding of dentin regeneration mechanism should be connected to the development of the dentin regeneration therapy.

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