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Self Assembly Peptides- Biomimetic Material

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Abstract: *Self-assembling peptides are a category of peptides which undergo spontaneous assembling into ordered nanostructures. As dentistry is moving towards minimal invasive methods there is a growing interest with regard to this new material. As with the use of these material dental caries can be prevented at an early stage thus preventing surgical process of cavity preparation and restorations.*

Keywords: *peptides, biomimetics, remineralization*

1. INTRODUCTION

Dental Caries is the most common disease worldwide. Inspite of advancement in technologies caries remains the singlemost widespread disease of the childhood. Dental caries is not a result of a single acid formed attack but rather a imbalance between demineralization and remineralization cycle occuring in oralcavity. For "early" carious lesions, current evidence suggests the use of noninvasive and nonrestorative methods like sealants and resin infiltration, remineralization procedures mainly with fluorides and CPP - ACP (casein phosphopeptide amorphous calcium phosphate) vehicles. Biomimetic self-assembling peptide, P_{11}−4, nucleated hydroxyapatite are new development and are apparently capable of *in situ* enamel regeneration following infiltration into caries-like lesions. [1]

2. CARIES BALANCE

During the demineralization process, calcium phosphate minerals, making up most of the enamel structure, is dissolved due to acidic pH and results in pores between crystallites. During remineralization, calcium phosphate supersaturated saliva redeposits minerals either on existing crystallites or triggers de novo formation of crystallites. This presents the natural regeneration process of the enamel tissue. [2] Enamel caries starts by subsurface demineralization, leaving a porous mineral surface covering the lesion body. After demineralization of approximately 30%, the mineralized surface collapses and breaks irreversibly. Biofilm removal and diet control support natural remineralization of the carious lesions via Ca2+from saliva. However, saliva's regenerative potential is restricted to the outer ~30 µm of the tooth enamel that is marginally affected by caries. Infiltration of lesion pores using low viscosity resins such as sealants has been demonstrated to halt caries progression in vitro, presumably by providing a barrier to diffusion within the lesion. [3,4]

A true regenerative approach, needs to aim at regenerating hydroxyapatite crystals within the subsurface. Traditional materials lack the ability to integrate with biological systems through a cellular pathway which resulted in the failure of these material. The use of biomimmetic material self-assembling peptide P11-4 have shown to regenerate demineralized tooth tissue on smooth surfaces. [5]

P11-4 is a bioactive peptide which is triggered by environmental conditions of pH to assemble into a three dimensional fibrillar scaffold. Hence P11-4 is a rationally-designed self-assembling peptide. It is synthesised from natural amino acids. Self-assembling peptides undergo well-characterized hierarchical self-assembly into three-dimensional fibrillar scaffolds in response to specific environmental triggers, offering a new generation of well-defined biopolymers with a range of potential applications. It form tapes and ribbons within seconds, and fibrils and fibers within the following 24 hrs.

P11-4 switches from a low viscosity isotropic liquid to an elastomeric pneumatic gel at pH <7.4 and in the presence of cations. These conditions assumed are usually seen within a caries lesion. There have been a number of in vivo and in vitro experiments, which showed that the assembled P11-4 fibers to be highly biocompatible with low immunogenicity. Following P11-4 self-

assembly, the anionic groups of other P11-4 side chains would attract Ca++ ions, inducing de novo precipitation of hydroxyapatite. [6]

The earliest clinical sign of enamel caries is the appearance of a 'white spot' lesion on the tooth surface. Clinicians monitor the lesion appearance and usually use topical fluorides and determine whether the lesion will progress. In case of progression restorations would be placed. Non-surgical intervention promoting bio mineralization or regeneration at the white spot lesion stage would remove the need for a surgical excavation of the tooth and placement of a restoration. [7]

Infiltration of early ('white spot') caries lesions using low viscosity monomeric P11-4 would result in triggered self-assembly within the lesion, generating a subsurface bioactive scaffold capable of recapitulating normal histogenesis by inducing mineral deposition in situ.

Peptide treatment have seen to significantly increase the net mineral gain due to a combined effect of deposition of mineral and inhibition of mineral loss.

P11-4 have a high affinity to hydroxyapatite and it has a potential to nucleate hydroxyapatite. The surface Ca2+ binding sites correspond exactly with the spacing of the Ca2+ ions in the hydroxyapatite crystal lattice. Self assembling peptide are known to form a 3D matrix within demineralized carious lesions forming denovo hydroxyapatite crystal. These peptides have shown encouraging results as a scaffold for enamel regeneration. [8,9]

In a randomized, controlled, single-blinded study, the safety and clinical efficacy of P11-4 in treatment of initial caries were evaluated using a randomized controlled trial (RCT) design. No adverse events, medical complications, or allergic reactions related to the treatments were reported. Clinical applicability was reported as easier than placing a filling or a sealant. All patients were willing to have future noninvasive treatments. In vivo and in vitro experiments, the assembled P11-4 fibers were shown to be highly biocompatible with low immunogenicity. In a study remineralization of natural carious lesions in human teeth, were monitored using the Canary System.

Canary Number of 40–50 (early carious lesions) remained basically unchanged for both control groups, but it reduced to values only slightly higher than that of sound enamel for the P11-4 group showing the reminerlising capacity of self assembling peptide P11-4. [10]

3. Conclusion

Self-assembling peptide P11-4 is a simple, safe, and effective noninvasive treatment for early carious lesions, and can be regarded as superior to the present clinical gold standard of fluoride treatment alone. However more clinical studies may be needed to completely understand the material.

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