Innovative methods of enamel remineralization in the treatment of early carious

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Abstract

In enamel, especially on free smooth surfaces, under the influence of certain factors, a dissolution of inorganic hydroxyapatite crystals can occur, and in this area, the enamel loses its translucency, becomes chalky, matte and rough, and the resulting structure is called a white spot lesion, this being the first objective clinical sign of caries also named the incipient carious lesion.

For this white spot lesion can be used the concept of minimally invasive dentistry, a very conservative way of intervention against enamel demineralization and any further substance loss.

An example of this minimally invasive dentistry concept is the use of the self-assembling peptide P11-4, one of the promising biomimetic alternatives for enamel remineralization. We showcase two clinical cases of white spot lesions treated with Regenamel®, a medical product that uses Curolox® Technology, based on self-assembling peptides.

Keywords: incipient carious lesion, remineralization, tooth enamel, Regenamel®, Curolox®

INTRODUCTION

Tooth enamel is the translucent, thin outer covering of the tooth and the hardest tissue in the human body [1]. Enamel development and mineralization is an intricate process tightly regulated by cells of the enamel organ called ameloblasts. During enamel development, enamel matrix proteins are known to control the disposition, morphology, and growth of the hydroxyapatite crystals [2]. The impact of developmental insults on enamel is critical because, unlike bone, once mineralized, enamel tissue is acellular and hence does not remodel [3].

Caries are considered a continuous dynamic process [4]. Enamel caries always starts through a process of subsurface demineralization leaving a microporous surface of lost minerals in-between the hydroxyapatite crystallites [5,6]. In enamel, especially on free smooth surfaces, under the influence of certain factors, a dissolution of inorganic hydroxyapatite crystals can occur, and in this area, the enamel loses its translucency, becomes chalky, matte and rough, and the resulting structure is called a white spot lesion, this being the first objective clinical sign of caries also named the incipient carious lesion [7]. For this white spot lesions can be used the concept of minimally invasive dentistry, a very conservative way of intervention against enamel demineralization and any further substance loss [5,8]. An example of this minimally invasive dentistry concept is the use of the self-assembling peptide P11-4, one of the promising biomimetic alternatives for enamel remineralization. The P11-4 peptide structure consists of natural amino acids: glutamine, glutamic acid, phenylalanine, tryptophan, and arginine. The resulting higher molecular structure has a high affinity for tooth mineral, and the high affinity for tooth mineral structure is based on the correspondence of the Ca ion binding site distances on P11-4 and the Ca spacing in the hydroxyapatite crystal lattice. Matrix formation is controlled by pH, therefore allowing control of matrix activity and site of formation [2,9,10]. The self-assembling peptide promotes the de-novo formation of hydroxyapatite within the carious lesions and is sold as Curodont™ Repair or Regenamel® [11]. Curodont™ Repair is marketed in Switzerland under the brand name Regenamel® [12]. This medical product uses Curolox® Technology, based on self-assembling peptides, forming a 3-dimensional matrix with a high affinity for the dental mineral [12]. When Regenamel® is applied to a tooth, the peptide diffuses into the subsurface micropores, forming a three-dimensional scaffold of tiny fibers. These scaffolds resemble teeth development proteins and promote hydroxyl apatite crystallization around them to restore tooth enamel over a three-month period [13].

Aim and objectives

In this case study, we aim to treat white spot lesions using a minim-invasive approach rather than a radical method of treatment.

MATERIAL AND METHODS

We showcase two clinical cases of white spot lesions.

The first one is an eight-year-old patient, with mixed dentition. The patient presents two removable orthodontic appliances (upper and lower), with anchoring elements for stability on 6.5 and 7.5. In the past, he presented dental sensitivity to strong stimuli. The teeth to which Regenamel® was applied are 6.5 (the upper left temporary second molar) and 7.5 (the lower left temporary second molar). They present carious lesions that are not detectable radiographically, as occlusal radiolucency is not present, but the clinical inspection reveals 6.5 superficial carious lesions located occlusally, in the middle (Fig. 1) and distal pits 7.5 superficial cavitary carious lesions located in the distal fossa (Fig. 2).

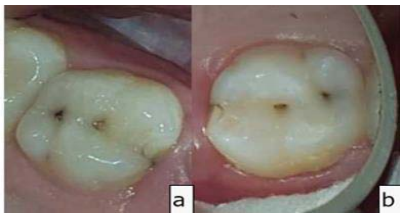

Figure 1. a, b The initial and final appearance of the carious lesion on tooth 6.5

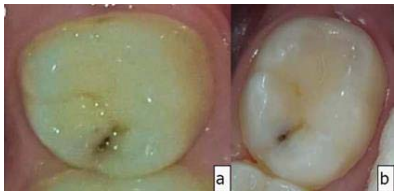

Figure 2. a, b The initial and final appearance of the carious lesion on tooth 7.5

The second one, is another eight-year-old patient, with mixed dentition. In the antecedents, he presents pain in the temporary teeth, with deep carious lesions, which indicates an increased susceptibility to caries. Radiological examination of the teeth to which Regenamel® was applied is 2.6 (the upper left permanent first molar) and 3.6 (the lower left permanent first molar). They present early carious lesions, which are not detectable radiographically, as no occlusal radiolucency is present. Clinical examination indicates that 2.6 shows multiple superficial carious lesions, non-cavitation, located in the distal, central fossa and in the occlusal-palatine groove (Fig. 3), and 3.6 shows multiple superficial carious lesions, non-cavitating, located at the level of grooves and pits of the occlusal surface (Fig. 4).

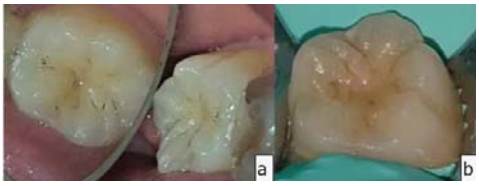

Figure 3. a, b The initial and final appearance of the carious lesion on tooth 2.6

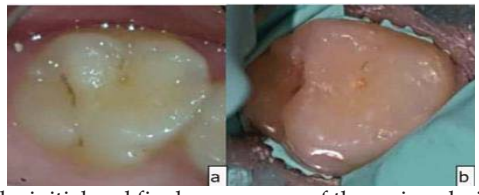

Figure 4. a, b The initial and final appearance of the carious lesion on tooth 3.6

For both patients, the same protocol was used as described: professional dental cleaning, removal of the pellicle using 2% sodium hypochlorite for 20 seconds, removal of the inorganic deposits using 35% phosphoric acid for 20 seconds, rinsing of the tooth surface with water, the drying the tooth surface with air and then applying of Regenamel®.

Regenamel® must be used exclusively by medical personnel. In the case of advanced carious lesions, Regenamel® produces only superficial mineralization and through repeated uses at 12-week intervals, remineralization becomes more effective. Topical applications with fluoride are only allowed 5 minutes after applying Regenamel® if applied before it can inhibit the action of Curolox® technology.

Currently, no side effects have been identified, but they cannot be completely excluded; as in the case of any dental treatment, this treatment can induce gingival

inflammation, pulp, and dentinal hypersensitivity. There is not enough data on side effects in pregnant women or during breastfeeding, therefore Regenamel® products should not be used in this case.

RESULTS

From a clinical point of view, the lesions are: diminished in terms of size, the appearance of the surrounding enamel is less infiltrated, and the color is darker, a sign of the chronicity of the lesion and the halt in evolution. When inspecting with the dental probe, the contour of the lesion is harder and smoother compared to that of the initial lesion, this fact being more obvious in the first case (in the two analyzed temporary teeth).

Repetition at certain time intervals, in order to increase the enamel remineralization rate could not be achieved due to the conditioning in terms of time, and in addition, the use of a combination of products containing Curolox® technology (e.g. toothpaste) is indicated. The results must be monitored at certain intervals and repeated as needed to facilitate enamel remineralization and the maintenance of the result largely depends on the patient's cooperation in terms of respecting oral hygiene, which is a decisive factor, instead, the dentist must very carefully evaluate the evolution of the process carious and establishing the application intervals of Regenamel®.

DISCUSSIONS

Technological evolution and the desire for minimally invasive treatment forced the creation of new treatment methods based mainly on the remineralization of carious lesions rather than on the removal of the carious process. Also new methods of discovering in advance the white spot lesions can be used before they progress to larger cavities. Quantitative light-induced fluorescence is a recent method that employs the use of fluorescent light to identify demineralized areas [14,15].

Fiber optic trans illumination-digital fiber-optic transillumination (FOTI/DIFOTI) is another new technique in which infrared light (780nm wavelength) is used to identify white spot lesions without the use of ionizing radiation [20]. Another recent method developed for the early identification of white spot lesions is near-infrared light transillumination (NILT), which uses optical fibers to transmit light (780nm wavelength) to the tooth via the root [16, 17]. A new technique known as Fluorescence Induced Theragnosis is very useful in diagnosing and helping manage white spot lesions, initial caries, and biofilm identification [18,19].

Chli and collaborators [20] state that the clinical trials about the efficacy of self-assembling peptides in masking the color of white spot lesions for achieving patient satisfaction appear to be insufficient for clinical guidance. Alsamolly, [21] assessed that the remineralization potential of self-assembling peptides increased by increasing the storage time (three months and six months).

Doberdoli D. and collaborators [22] concluded that using the self-assembling peptide with fluoride varnish or twice weekly application of Curodont Protect (self-assembling peptide matrix containing P11-4, fluoride, and calcium phosphate), had improved the enamel repair and arrest WSLs over fluoride varnish alone. This statement was in agreement with Alkilzy and collaborators [23] who stated that there was a statistically significant overpowering from the combination of the self-assembling peptide with fluoride, over the use of fluoride alone.

CONCLUSIONS

The approach of carious lesions is based in recent years mainly on the concepts of prevention, minimally invasive, and remineralization, which Regenamel® fully respects, that is why this material and its technology are in the first places, thanks to the results obtained from the point of histological view, through a multitude of studies carried out in vitro and on clinically obtained results, but we are still far from achieving a true restoration of the lost enamel, clinically detectable. Unfortunately, there is still no clear evidence to support the theory and long-term studies showing the stability of the "regenerated" enamel over a long period of time, which could be a direction in which research should continue.

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