Case Report

Effectiveness of self-assembling peptide P11-4 as a minimally invasive intervention for initial smooth-surface carious lesions in permanent teeth: A case report

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ABSTRACT

White spot lesions (WSLs) are the earliest visible manifestation of enamel caries and present significant esthetic concerns, particularly in adolescents. Conventional treatments, such as fluoride, casein phosphopeptide-amorphous calcium phosphate, and resin infiltration, have limitations, including incomplete remineralization or irreversible enamel alteration. Self-assembling peptide P11-4 (SAP P11-4; Curodont Repair, Credo AG, Switzerland) is a biomimetic material that promotes subsurface hydroxyapatite formation within the lesion body. A 16-year-old female presented with International Caries Detection and Assessment System 1–2 WSLs on the labial surfaces of teeth 11, 12, 21, and 22. Clinical examination excluded fluorosis, enamel hypoplasia, and post-orthodontic demineralization. Following surface preparation, SAP P11-4 was applied under rubber dam isolation. The procedure was well tolerated, with no adverse events. Progressive reduction in lesion opacity was observed, with favorable esthetic and structural outcomes maintained at 1 year, supporting SAP P11-4 as a minimally invasive treatment option.

Key words: Biomimetic remineralisation, Enamel caries, Hydroxyapatite, Minimally invasive dentistry, Self-assembling peptides, White spot lesions

White spot lesions (WSLs) are the earliest clinically detectable stage of dental caries. They appear as chalky-white opacities on smooth enamel surfaces and result from subsurface demineralization without surface cavitation [1]. The reported prevalence of WSLs in adolescent populations ranges from 20% to 80%, making this condition a significant priority in contemporary preventive and conservative dentistry [2]. These lesions affect the esthetic anterior zone primarily and are associated with measurable psychosocial distress, especially among adolescent patients and young adults [3].

Traditional management has relied on topical fluoride supplementation, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), and resin infiltration. Fluoride primarily reinforces mineral deposition at the outermost enamel surface but has limited diffusion into the subsurface lesion body, restricting its ability to restore optical translucency [4]. CPP-ACP stabilizes calcium and phosphate ions at the enamel surface and has been proposed as a demineralizing reservoir system, yet clinical trials report variable esthetic outcomes across patient cohorts [5]. Resin infiltration achieves visual masking by filling enamel microporosities with a low-viscosity resin, but it requires irreversible surface etching and carries a documented risk of marginal discoloration over time [6]. These collective limitations have driven the search for biologically driven, structure-preserving alternatives.

Self-assembling peptide P11-4 (SAP P11-4) (Curodont Repair, Credo AG, Switzerland) is a rationally designed biomimetic agent for enamel regeneration. The peptide consists of eleven amino acids arranged in a beta-sheet conformation. Under physiological pH conditions, P11-4 monomers diffuse into enamel microporosities and self-assemble into a three-dimensional fibrillar scaffold that promotes guided nucleation of de novo hydroxyapatite crystals within the lesion body [7]. This mechanism targets subsurface mineral regeneration directly, fundamentally distinguishing it from surface-focused remineralization strategies [8]. The clinical safety of P11-4 was first established by Kind *et al*. [9], who reported significant lesion regression following

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a single application in adult patients with Class V WSLs. Subsequent randomized controlled trials by Kirkham *et al*. [10] confirmed superior International Caries Detection and Assessment System (ICDAS) score regression when P11-4 was combined with fluoride varnish compared with fluoride alone.

Despite a growing body of evidence supporting SAP P11-4, reports documenting its use in adolescent patients with multiple smooth-surface WSLs and long-term clinical follow-up remain limited. Furthermore, photographic documentation demonstrating progressive esthetic improvement over an extended period is scarce. Therefore, the rationale for reporting this case is to illustrate the clinical application, patient-centered outcomes, and 1-year effectiveness of SAP P11-4 in managing multiple early enamel carious lesions in an adolescent patient. Published case reports with complete photographic documentation and 1-year follow-up in adolescent patients with multi-tooth smooth-surface involvement remain sparse. This case report describes the clinical management of multiple non-cavitated WSLs in a 16-year-old female using SAP P11-4, with outcomes documented immediately after treatment, at 6 months, and at 1 year.

CASE REPORT

A 16-year-old female presented to the Department of Conservative Dentistry and Endodontics with a chief complaint of white spots on her upper front teeth affecting her smile appearance. She described the gradual development of the opacities over several months. She reported no pain, sensitivity, or functional disturbance associated with the affected teeth. She was systemically healthy with no history of chronic illness, medication use, or allergy. Her family history was negative for enamel developmental defects.

Her decayed-missing-filled teeth index, recorded according to the method described by Klein *et al*., was 4 [11], with existing restorations on teeth 16, 26, 36, and 46. Her oral hygiene index-simplified (OHI-S), assessed according to Greene and Vermillion, was 1.5, corresponding to fair oral hygiene [12]. The absence of prior orthodontic treatment excluded post-orthodontic demineralization as a causative factor. Clinical examination under standardized illumination revealed smooth, sharply demarcated chalky white opacities on the labial surfaces of teeth 11, 12, 21, and 22. The enamel surfaces were intact, with no cavitation, roughness, or sensitivity on probing. Lesions were classified as ICDAS scores 1–2 [13]. Dental fluorosis was excluded due to its localized distribution and the absence of a history of excessive fluoride exposure. Enamel hypoplasia was ruled out because the enamel was smooth and free of pits or grooves. Molar incisor hypomineralization was considered unlikely due to the absence of yellow-brown opacities, post-eruptive breakdown, hypersensitivity, and first molar involvement. The lesions were diagnosed as initial smooth-surface enamel carious lesions (WSLs).

All procedural steps were performed under rubber dam isolation, maintaining a moisture-free environment during SAP application, consistent with evidence supporting the use of rubber dam isolation for adhesive and demineralizing procedures [14]. The manufacturer-recommended standardized four-step clinical protocol for P11-4 application was followed, as presented in Table 1. No anesthesia was administered at any stage. Post-operative instructions were provided orally and in written form. The patient was advised to avoid pigmented foods and beverages for 24 h, use non-fluoridated toothpaste for 1 week, and maintain rigorous oral hygiene practices to support remineralization [15].

Pre-operative clinical photographs confirmed the distribution and character of WSLs on teeth 11, 12, 21, and 22. The lesions presented as chalky, dull-white opacities with sharp demarcation on the labial enamel surfaces, consistent with subsurface demineralization (Fig. 1a) [16]. All lesions were non-cavitated and clinically accessible for direct SAP application.

Rubber dam isolation was achieved without difficulty (Fig. 1b). Surface preparation with 2% sodium hypochlorite was applied to each lesion with a microbrush for 20 s to remove organic debris and biofilm and expose subsurface microporosities (Fig. 1c) [4]. A 37% phosphoric acid gel was then applied to the lesion surfaces for 20 s to remove the hypermineralized surface layer and create microporosities that would facilitate deeper infiltration of P11-4 (Fig. 1d).

Following etching, the lesions were rinsed with water for 20 s and gently air-dried to remove all residual acid and create a clean, moist surface suitable for peptide application (Fig. 2a). Curodont repair (P11-4) was applied using a microbrush to completely cover all WSLs (Figs. 2b and c). The material was left undisturbed for 5 min under rubber-dam protection to prevent salivary contamination during self-assembly (Fig. 2d) [17]. Excess material was then removed without water rinsing to maintain continued peptide-enamel contact during the initial post-operative period (Fig. 3a).

The procedure was completed in approximately 30 min. The patient reported no discomfort during or after

Table 1: Stepwise clinical protocol for SAP P11-4 (curodont repair) application

S. No.	Step	Agent/Material	Duration
1	Surface cleaning	2% NaOCl applied with a microbrush	20 s
2	Surface etching	37% phosphoric acid gel applied with a microbrush	20 s
3	Rinsing and drying	Water spray rinse followed by gentle air drying	20 s
4	SAP P11-4 application	Curodont repair (Credo AG, Switzerland)	5 min undisturbed

SAP: Self-assembling peptide, NaOCl: sodium hypochlorite

the procedure. No anesthesia was required at any stage. No adverse events or unexpected complications occurred during treatment. Upon rubber dam removal, treated surfaces showed early, perceptible changes in opacity relative to the pre-operative baseline, consistent with initial peptide infiltration and nascent hydroxyapatite nucleation [1].

At the 6-month follow-up, clinical examination and standardized photography confirmed a marked reduction in lesion opacity in all four treated teeth (Fig. 3b). The treated enamel areas blended more closely with the surrounding healthy enamel in color and translucency, reflecting progressive mineral deposition within the lesion body [2]. Tactile examination with an explorer confirmed smooth, intact enamel surfaces with no evidence of cavitation, roughness, or deterioration at any treated site. The patient reported high satisfaction with the esthetic improvement and no post-operative sensitivity. At the 1-year review, the favorable outcomes were fully maintained (Fig. 3c). No recurrence of white opacities, surface staining, marginal discoloration, or caries progression was observed on any treated surface [3]. The patient remained caries-free and reported no functional or esthetic concerns.

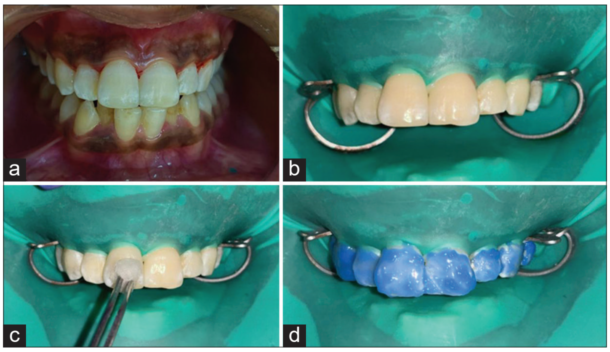

Figure 1: (a) Pre-operative view showing chalky white opacities on teeth 11, 12, 21, and 22. (b) Rubber dam isolation is in place. (c) Surface preparation using 2% sodium hypochlorite applied with a microbrush for 20 s. (d) Etching of the white spot lesions with 37% phosphoric acid gel applied for 20 s

DISCUSSION

This case report documents the successful management of multiple smooth-surface WSLs using SAP P11-4 in a 16-year-old female, with progressive esthetic improvement confirmed at 6 months and stable outcomes at 1 year. The findings are consistent with published clinical and *in vitro* evidence supporting biomimetic remineralization as a viable, structure-preserving alternative to conventional WSL management approaches [4,5]. The patient's OHI-S score of 1.5 falls within the "fair" oral hygiene category according to Greene and Vermillion (0.0–1.2 = good, 1.3–3.0 = fair, 3.1–6.0 = poor). Although oral hygiene was not optimal, the absence of heavy plaque accumulation and the patient's compliance with oral hygiene instructions likely contributed to the favorable remineralization outcome observed during follow-up.

The mechanism underlying P11-4 efficacy distinguishes it from all currently available WSL treatments. Unlike topical fluoride, which promotes calcium fluorapatite deposition predominantly at the outermost enamel surface, P11-4 monomers in their unassembled form are sufficiently small to diffuse through enamel microporosities into the lesion body [6]. Once within the lesion, the pH-responsive peptide self-assembles into higher-order fibrillar structures that mimic the organic matrix of developing enamel and serve as nucleation sites for *de novo* hydroxyapatite crystallization [7]. Murdoch-Kinch and McLean [8] demonstrated this mechanism using confocal microscopy, micro-computed tomography, and scanning electron microscopy, confirming that SAP P11-4 achieves genuine subsurface mineral regeneration rather than superficial remineralization. This distinction explains the progressive improvement in translucency observed at 6 months and 1 year in our patient.

The pre-treatment preparation steps were integral to achieving effective SAP infiltration. Surface cleaning with 2% sodium hypochlorite removed the organic pellicle and biofilm covering the lesion surface, directly

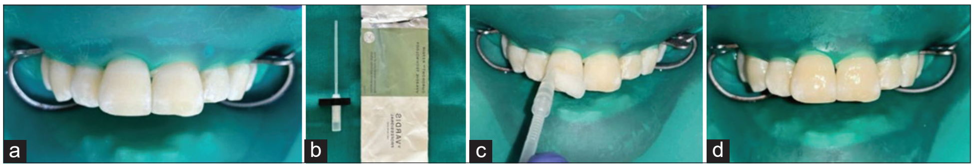

Figure 2: (a) Thorough rinsing with water (20 s) and gentle air drying of the lesion surface. (b) Curodont repair (self-assembling peptide [SAP P11-4]) product. (c) Application of SAP P11-4 to all lesion surfaces using a microbrush. (d) Material left undisturbed in place for 5 min under rubber-dam isolation

Figure 3: (a) Immediately post-operative view following self-assembling peptide P11-4 application. (b) Six-month follow-up showing marked reduction in opacity and integration of treated areas with the surrounding healthy enamel. (c) One-year follow-up confirming sustained esthetic improvement and stable enamel integrity

exposing underlying microporosities to subsequent etching and peptide application. Phosphoric acid etching at 37% for 20 s removed the hypermineralized, relatively impermeable surface layer that typically overlies active WSLs. This step was identified by Kind *et al*. [9] as critical for achieving adequate P11-4 diffusion depth and meaningful clinical improvement. Rubber dam isolation throughout the procedure ensured no salivary contamination occurred during the 5-min self-assembly window, consistent with Cochrane evidence supporting rubber dam use for moisture-sensitive dental procedures [10].

When compared with conventional WSL management strategies, the advantages of P11-4 become evident. Fluoride-based remineralization reinforces the outermost enamel surface but cannot reconstitute the optical translucency of the subsurface lesion body, which is the primary determinant of the white clinical appearance [13]. CPP-ACP provides a bioavailable calcium-phosphate reservoir, but evidence from systematic reviews for meaningful esthetic WSL improvement remains inconsistent [14]. Resin infiltration achieves immediate optical masking and has been shown in a meta-analysis to significantly outperform fluoride varnish alone for esthetic improvement [15], but this comes at the cost of irreversible enamel etching and potential long-term marginal discoloration. The network meta-analysis by Wong *et al*. [16] found that P11-4 combined with fluoride varnish and resin infiltration represented the most effective strategies for WSL management. In the present case, P11-4 monotherapy achieved favorable esthetic outcomes without irreversible enamel modification, preserving the integrity of the complete tooth structure.

The clinical outcomes in this case align closely with those reported in published controlled studies. Xie *et al*. [17] reported a statistically significant reduction in WSL size as early as 30 days following a single P11-4 application in an adult safety cohort. Alkilzy *et al*. [1] demonstrated in a randomized controlled single-masked trial that P11-4 plus fluoride varnish was 5.1 times more likely than fluoride varnish alone to achieve ICDAS score regression at 6 months. Alkilzy *et al*. [2] confirmed superior remineralization by impedance measurement in P11-4-treated sites over 180 days in a split-mouth randomized trial involving 23 orthodontic patients. *In vitro* evidence from Bourouni *et al*. [3], in a systematic review of 12 studies, further supports the use of P11-4 for effective enamel remineralization compared with control conditions. Brunton *et al*. [4] demonstrated in a direct comparative pH-cycling study that P11-4 achieved greater mineral gain than fluoride solutions alone. The comprehensive review by Honorio and Ten Cate [5] confirmed P11-4 as biologically sound for caries management across different age groups and clinical settings.

This case conforms fully to the principles of minimally invasive dentistry [6]. No tooth structure was removed, no local anesthesia was administered, no restoration was placed, and no irreversible alteration of enamel was performed. Total chairside time was approximately 30 min, and the procedure was well tolerated. High patient satisfaction was documented at both follow-up visits. These characteristics make SAP P11-4 particularly suitable for adolescent patients in whom cooperation, anxiety, and the desire for esthetic improvement are important clinical considerations.

Several limitations of this report should be acknowledged. Despite its promising clinical performance, SAP P11-4 has limitations related to cost and accessibility. Compared with conventional fluoride therapies, curodont repair is more expensive and may be less accessible in low-resource settings, potentially affecting patient affordability and widespread adoption. This report is also limited by its single-patient design involving four teeth, restricting generalizability. The lesions were early-stage (ICDAS 1–2), and outcomes may differ in more advanced lesions. Objective assessment of mineral gain was not performed, limiting mechanistic interpretation. Furthermore, follow-up was limited to 1 year, and the long-term durability of P11-4-induced remineralization remains insufficiently documented [7,8].

CONCLUSION

SAP P11-4 (curodont repair) represents a clinically effective, biologically sound, and minimally invasive strategy for managing smooth-surface WSLs in permanent teeth. A 16-year-old female was treated using a standardized four-step protocol. The absence of irreversible enamel modification, avoidance of anesthesia, and favorable patient experience collectively support P11-4 as a preferred first-line option for managing early enamel caries in young patients. Larger multicenter randomized trials with extended follow-up and objective assessment of mineral density are needed to fully establish long-term durability and to define standardized protocols for routine clinical practice.

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