

IN BRIEF

- The incidence of root surface caries is on the rise and has been identified as a substantial dental health problem.
- Application of the combined CPP-ACP and PAD therapy proved to be a successful treatment approach in arresting root surface caries.
- The findings presented hold great potential in the area of preventive dentistry and as such are of great relevance both to dental clinicians and dental researchers.
- The case report provides the framework for more extensive *in vivo* trials.

VERIFIABLE
CPD PAPER

Combined CPP-ACP and photoactivated disinfection (PAD) therapy in arresting root surface caries: a case report

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A 19-year-old male was referred to the School of Dentistry, University of Queensland for management and treatment of uncontrolled root caries. A total of 12 teeth had non-cavitated root carious lesions requiring treatment. The lesions were treated with a daily application of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP; GC Tooth Mousse) and in-surgery photo-activated disinfection (PAD). Laser fluorescence (KaVo Diagnodent) was used to monitor the changes in the carious lesions. The combination of CPP-ACP and PAD proved to be very effective and holds great potential as a recommended treatment for stabilising root surface caries in the clinical practice.

CASE REPORT

A 19-year-old male was referred by his dentist to the School of Dentistry, University of Queensland for management and treatment of uncontrolled root caries. Oral symptoms included dryness upon waking and generalised hypersensitivity to sweet and cold foods. Medical history revealed the presence of previous gastro-intestinal pathology with associated malabsorption, occasional episodes of spontaneous gastric reflux, and ventolin-controlled asthma. Lifestyle and dietary analysis found a caffeine intake of approximately 200 mg a day, a modest intake of acidic beverages, notably ginger beer, low water intake, a

smoking habit of 15 cigarettes a day, and a history of a high intake of cola. The patient also had a habit of daily cannabis use up until 12 months ago.

Clinical examination showed dryness of the oral cavity, significant levels of plaque on the tongue, reduced resting salivary flow rate (1.0 ml/min), increased salivary viscosity and a reduced resting pH of 5.6. Stimulated salivary flow rate, pH and buffering capacity were all within normal parameters, excluding the presence of salivary gland pathology, identifying lifestyle and dietary factors as the main cause. A total of 12 teeth had non-cavitated root carious lesions requiring treatment (Figs 1-3). The patient brushed his teeth with regular fluoridated toothpaste on a daily basis (Colgate™, sodium fluoride 0.22 % w/w).

Following the initial assessment the patient was scheduled in for the first (baseline) appointment to allow for collection of baseline data and commencement of treatment. To maintain consistency and reproducibility a single operator conducted all the clinical treatment and the Diagnodent readings.

TREATMENT

The patient was placed on a protocol of daily (overnight) application of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP; GC Tooth Mousse) with in-surgery photo-activated disinfection (PAD) treatment at baseline at one month, two month, three month, six month and 12 month appointments. Both therapies have shown great success individually, yet the potential benefit of utilising them as a combined therapy has not been investigated. Following tooth brushing, the patient applied the CPP-ACP topically to the affected teeth, with his finger. Aside from toothpaste, no other dental products were used. PAD therapy entailed topical application of toluidine blue (tolonium chloride) dye followed by immediate irradiation with the 635 nm InGaAsP diode laser (SaveDent™, Denfotex, Scotland) as per manufacturer instructions (energy density 15.3 J/cm², spot size 5 mm, 632 nm wavelength, 100mW with 30 seconds exposure). After laser irradiation the dye was immediately rinsed off with water from the triplex syringe.

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Laser fluorescence (KaVo Diagnodent) was used to monitor the changes in the carious lesions. The presence of plaque, calculus and staining can compromise readings, and as such, a thorough cleaning of the teeth surfaces was undertaken prior to every measurement. Also, at the start of each appointment the Diagnodent was calibrated as per manufacturer instructions.

RESULTS

The Diagnodent data were analysed using the Repeated Measures ANOVA test (RMANOVA), with Tukey Kramer Multiple Test as the chosen MCP (Multiple Comparison Procedure).¹ P-value is significant at alpha = 0.05.

RMANOVA gave a p-value of 0.000101, in support of the alternative hypothesis that there is a significant change in the Diagnodent measurements with time (months) (Table 1). The Tukey Kramer test showed a difference with time to be between zero months and 12 months with no difference between zero months, one, two, three and six months (Table 2).

DISCUSSION

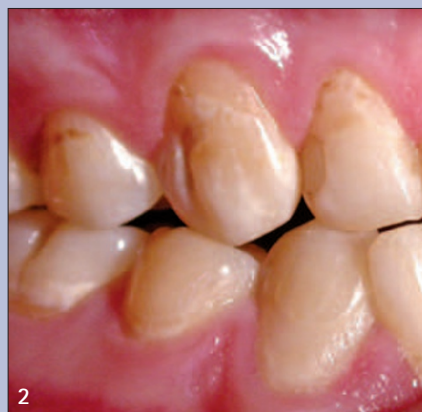
The protective nature of casein phosphopeptides (CPP) has been investigated for many years with successful *in vitro*, *in situ* and *in vivo* results.²⁻¹⁷ Derived from the milk protein, casein, and digested by the enzyme trypsin, one of the most important features of CPP is their ability to stabilise amorphous calcium phosphate (ACP), preventing its precipitation in solution. The spectrum of action of the CPP-ACP complex is broad, buffering pH, preventing demineralisation and allowing for remineralisation.^{8,14-16}

The bond between the CPP and the ACP is pH dependent and declines as the pH drops off. Thus, in the presence of an acid attack, the CPP-ACP molecular bond disassociates¹⁶ with a resultant increase in free calcium and phosphate ions. In addition to the above, CPP-ACP are also a reservoir of the neutral ion species, CaHPO₄⁰. This accounts for an additional and important property of CPP-ACP, that being the buffering of plaque pH. Under acidic conditions, CPP-ACP will dissociate and release calcium, phosphate and neutral CaHPO₄⁰ ions that neutralise and buffer the acids produced in the plaque. These acids typically originate as a by-product of carbohydrate fermentation by plaque bacteria, from an external or

Table 1 Repeated measures analysis of variance

Source term	DF	Sum of Squares	Mean square	F-ratio	Probability level	Power
A: Tooth	11	30666.49	2787.862	6.35	0.000101*	0.993866
B: Months	5	1589.569	317.9139			
AB	55	2753.264	50.05935			
S	0					
Total	71	35009.32				
(Adjusted)	72					
Total						

*Term significant at alpha = 0.05



Figs 1-3 A total of 12 teeth had non-cavitated root carious lesions requiring treatment

internal source, or during the process of hydroxyapatite formation.¹⁶ For this patient the buffering capacity stayed at an optimal level as measured with the GC Saliva Check Buffer™ kit.

For many years now photodynamic therapy (PDT) has been utilised in the treatment of tumours, whereby through selective binding and laser light activation of the photosensitive drug, a tumour mass is destroyed.¹⁸

After its successful implementation in medicine, research extended to the application of this therapy in the killing of oral bacteria, with many successful results in this field against a wide scope of oral bacteria.¹⁹⁻²⁹ The mechanism of action of PAD therapy is governed by the interaction of a photosensitive antimicrobial agent and a selective laser light

source. PAD therapy works by means of the formation of labile singlet oxygen or radicals, which trigger a cascade of redox reactions, the end result of which is the destruction of bacterial cells and their cellular components.³⁰

With the above noted bactericidal action of PAD and the remineralisation capabilities of CPP-ACP, the two therapies complement and optimise their respective effectiveness.

Analysis of the Diagnodent data found a statistical difference between baseline (zero months), one, two and three months with that of 12 months. Interestingly the change at six months is almost midway between the baseline and the 12 months, but not different enough to be deemed as significant (Table 2). The data can also be presented based on the

Table 2 Tukey-Kramer Multiple-Comparison Test

Group	Count	Mean	Different from Groups
0	12	35	12
1	12	30.41667	12
2	12	34.5	12
3	12	30.58333	12
6	12	27.58333	
12	12	21	0, 1, 2, 3

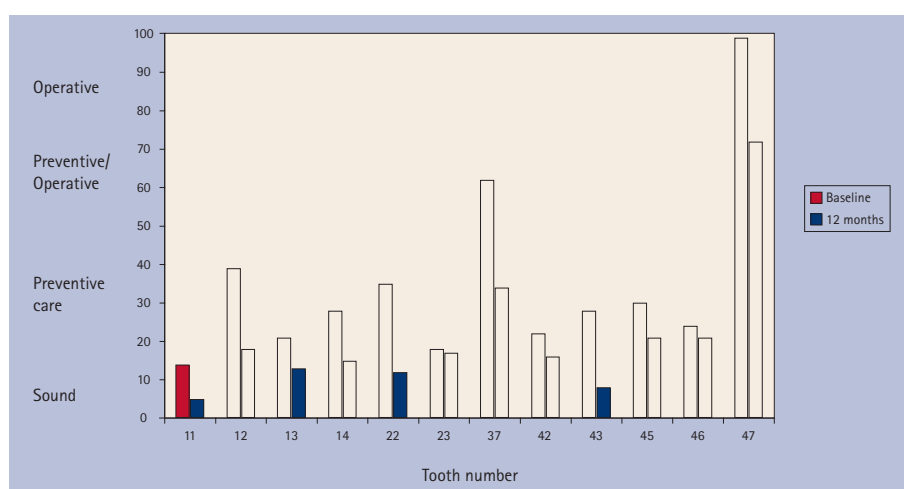


Fig. 4 Change in Diagnodent measurements for teeth treated with CPP-ACP and PAD, over a period of 12 months

recommended guidelines.³¹ Namely, at baseline (zero months), five teeth required operative care, five required either operative or preventive depending on the caries risk, and two were sound requiring only preventive care. By the twelfth month, two needed operative care, two were in the restorative/preventive (at the bottom end of the scale) category and eight were in the sound/preventive category (Fig. 4).

CONCLUSION

In light of the above findings we propose that PAD therapy enhances the effectiveness of CPP-ACP by removing the cariogenic bacteria. The combination of CPP-ACP and PAD proved to be very effective and holds great potential as a recommended treatment for stabilising root surface caries in the clinical practice.

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