MI Paste™
MI Paste Plus™

Anthology of Applications

Professor Laurie Walsh | University of Queensland, Australia

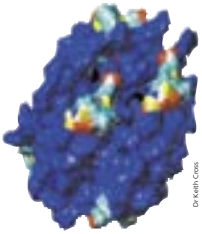
GC

SKU 600707

INTRODUCTION

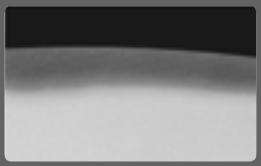
The MI Paste™ and MI Paste Plus™ series of products is based on Recaldent™ (CPP-ACP) technology. The same technology can be put into gums, lozenges, rinses and a number of other materials. A range of chewing gums around the world have incorporated the Recaldent™ (CPP-ACP) technology to enhance the remineralization properties of these chewing gums*.

The Recaldent™ (CPP-ACP) technology was developed in Australia at the University of Melbourne, especially to capitalize upon the anti-caries properties of milk.

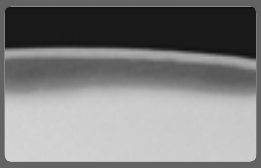


Molecular model of the CPP-ACP complex. Casein phosphopeptide (CPP) is a milk derived protein able to bind calcium and phosphate ions and stabilize them as Amorphous Calcium Phosphate (ACP).

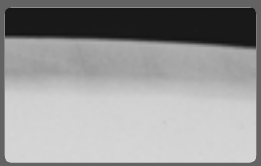
Dr Keith Cross



» Demineralized tooth surface (white spot lesion).



» After application of a 1ml solution of 1000 ppm fluoride for one minute four times daily for 14 days. The tooth surface has been remineralized but the subsurface lesion is intact.



» After application of Recaldent™ (CPP-ACP) for one minute four times daily for 14 days. A significant improvement can be seen compared to 1000 ppm fluoride.

ABOUT THE AUTHOR

Lauence Walsh has been Professor of Dental Science at the University of Queensland since 1999, and has been Head of that School since 2004. In addition to his academic responsibilities, Laurence runs a part-time special needs dentistry clinic and serves as an advisor to the Australian government and to the dental industry. Laurence is well known for his work in the area of dental technologies, where he has been involved in the invention, development and evaluation of a range of dental products and technologies. He has lectured in over 20 countries and has published extensively in dental literature. Laurence has played a substantial role in the development of clinical protocols for patient assessment, such as saliva tests and plaque tests, and has authored a range of education material for clinicians as well as several textbooks and multimedia products. Through his own clinical practice over the past decade, he has developed and optimized clinical protocols for using MI Paste for treating dental fluorosis, hypomineralization, white spots and other enamel lesions.

» (CPP-ACP) refers to a complex of caesin phosphopeptides and an amorphous form of calcium phosphate in which the CPP maintains/stabilizes the calcium and phosphate ions in an amorphous form without precipitation to insure the delivery of the ions into the tooth structure before they precipitate/crystallize.

* References

Enamel remineralization by chewing gum containing casein phosphopeptide-amorphous calcium phosphate. Reynolds EC, Shen P, Cai F, Nowicki A, Vincent J. IADR, General session, Chiba, Abstract 0489,2001

Remineralization of enamel subsurface lesions by sugar-free chewing gum containing casein phosphopeptide-amorphous calcium phosphate. Shen P, Cai F, Nowicki A, Vincent J, Reynolds EC. J Dent Res 2001 Dec 80:12 2066-70

Retention in plaque and remineralization of enamel lesions by various forms of calcium in a mouthrinse or sugar-free chewing gum. Reynolds EC, Cai F, Shen P, Walker GD. J Dent Res 2003 Mar 82:3 206-11

MI Paste releases Recaldent™ (CPP-ACP) which adheres to soft tissue, plaque, pellicle and hydroxyapatite delivering amorphous calcium and phosphate into the saliva and plaque fluid. The mechanism of action is similar to that of the salivary protein statherin and the supply of bioavailable calcium and phosphate is able to drive remineralization, buffer acid and reduce the plaque acid effect on tooth structure.

An analysis of the chemistry of demineralization and remineralization indicates that a major source of mineral loss in the caries process is the destruction of apatite with the creation of water as a by-product, and the leakage of a neutral species calcium hydrogen phosphate across a porous enamel surface.

When placed on the surface of a tooth, Recaldent™ (CPP-ACP) interacts with hydrogen ions and forms the same species calcium hydrogen phosphate which, under a diffusion gradient, can enter into the tooth, react with and consume the water to produce enamel mineral, thereby removing subsurface mineral defects.

In vivo studies of the remineralization properties of Recaldent™ gum have shown subsurface mineral gain can occur by chewing the gum for periods of fifteen minutes for two weeks.

The levels of enamel subsurface remineralization which can be achieved using Recaldent™ sugar free gum are much greater than those which can be achieved using conventional sugar-free chewing gums because of the intense loading of calcium and phosphate in a ratio which is ideal for remineralization.

MI Paste treatment of enamel subsurface caries has been shown to cause rapid remineralization, and this causes a change in the appearance of the lesions.

Any incipient white spot lesions which are developing because of cariogenic plaque can be treated locally with Recaldent™ (CPP-ACP) to achieve subsurface remineralization. This will occur in fairly short periods of time – in the order of two to four weeks.

A key principle with Recaldent™ (CPP-ACP) is that the longer the material is maintained in the mouth, the more effective the result. MI Paste, which is the recommended homecare form of the product, contains 10% of the Recaldent™ (CPP-ACP) molecule by weight.

Recaldent™ (CPP-ACP) works in combination with environmental fluoride sources. For example, in patients who chew Recaldent™ gum or apply MI Paste immediately after tooth brushing with a fluoride toothpaste, the fluoride will combine with and enhance the remineralizing activity. A single application of MI Paste can be useful after professional fluoride applications, after scaling and root planing or for desensitizing areas that have sensitive dentin.

An additional and separate product, MI Paste Plus™, has also been developed which contains 900 parts per million (ppm) sodium fluoride (0.2%).

Method of clinical application

MI Paste is pleasant tasting, and can be applied directly with a clean finger onto the teeth, smeared over all surfaces and left in place to slowly dissolve overnight. Any material that is swallowed is completely safe, and will contribute towards dietary calcium.

Night time procedure. Squeeze a small amount of MI Paste onto the finger.

Apply to the teeth using the tongue to help spread evenly over the entire surface.

Prof. Laurie Walsh

Leave for at least three minutes. Expectorate but do not rinse. Leave the excess to slowly dissipate.

SUMMARY

MI Paste works well in combination with fluoride. Apply MI Paste at night over all tooth surfaces and leave to dissipate without rinsing. The longer MI Paste is retained on the tooth surface, the better the result.

TREATMENT OF WHITE SPOT LESIONS

Clinical Case

In cases of incipient carious lesions, the subsurface water can be converted back into enamel because of the neutral ions species moving by diffusion through the porous surface. When it reacts with the water, the hydroxyapatite formed will regenerate in the subsurface space. Once 80%-85% regeneration has occurred, the enamel will appear optically normal. This means that the appearance of the white spot lesion also disappears.

For existing active white spot lesions, there is no need to etch prior to applying MI Paste, whereas in arrested lesions, these can be etched for fifteen seconds with orthophosphoric acid to make the surface permeable.

Considerable work has been undertaken confirming that MI Paste can reverse the visible appearance of white spot lesions. Moreover, it can rebuild other areas that are water-rich, demineralized or otherwise defective, such as orthodontic decalcification, fluorosis and excessively bleached teeth. As a post-orthodontic treatment finishing measure, MI Paste treatment is highly recommended since it gives the teeth their maximum protection for the future, as well as any small areas of decalcification which may have occurred, even in patients with fastidious oral hygiene during orthodontic treatment.

» At the first appointment, prior to treatment, the broad areas of opacity can be seen affecting all the teeth. The maxillary anterior teeth previously had composite resin veneers placed, and areas of decalcification can be seen at the cervical margins.

» The situation after etching and microabrasion followed by 12 weeks of a daily application of MI Paste shows a dramatic change in the appearance of the lesions.

Prof. Laurie Walsh

» These higher magnification views show the before and after situations. There has been a reversal of the white spot lesions and the fully remineralized enamel is normal in appearance.

SUMMARY

The patient now has excellent oral hygiene even though her salivary parameters are abnormally low due to multiple medical conditions and medications. Her salivary profile should be checked regularly using the GC Saliva Check Buffer test. She should continue to apply MI Paste nightly.

PROBLEMS THAT CAN OCCUR DURING/AFTER ORTHODONTICS

Fixed or removable orthodontic appliances are plaque traps because cariogenic bacteria prefer growing on hard, non-shedding surfaces. With increased levels of cariogenic bacteria in the mouth, caries risk increases during orthodontic treatment as seen below.

MI Paste can help prevent plaque accumulation around brackets, archwires, springs and other appliances, and can assist the saliva in buffering acids produced by dental plaque.

In this way, a regular application of MI Paste during orthodontic treatment can prevent areas of decalcification developing. White spot lesions can be arrested and reversed but it is important to use MI Paste routinely throughout the full course of orthodontic treatment.

Prof. Laurie Walsh

Apply MI Paste twice daily to prevent plaque accumulation around brackets, archwires, springs etc.

Clinical Case

Immediately after bracket removal.

A five minute twice daily application produced these results – at one month.

Dr H. Hayashi

After three months.

SUMMARY

In order to avoid the incidence of white spots, it is recommended to apply MI Paste twice daily for the entire period that brackets are in place or an extra-oral appliance is in use.

REMOVAL OF BONDING RESIN AFTER ORTHODONTIC TREATMENT

Clinical Case

At the end of fixed orthodontic treatment, MI Paste offers the perfect finishing treatment to optimize the appearance of the enamel, particularly of the maxillary incisor teeth. It is common for small residues of bonding resin to remain on the teeth after the removal of brackets, which lower the reflectivity of the surface. These residues are not visible to the naked eye, but are easily seen in contrast if the tooth surface is etched for 10-15 seconds. After further surface polishing, re-etch the teeth to check that all resin has been removed. Finally, a gentle microabrasion prepares the enamel for the action of MI Paste. This treatment is ideally undertaken at the debanding visit, with the patient being given a tube of MI Paste to use at home over the following weeks.

Extra-oral and intra-oral views of the baseline situation after debanding.

Application of phosphoric acid etchant gel to the maxillary incisor teeth, just short of the gingival margin.

Residues of resin are easily seen contrasting with the etched enamel.

After removal of the resin, a second etch confirms that the enamel surface is even.

Prof. Laurie Walsh

The situation immediately after microabrasion. Some minor odontoplasty was then done to smooth and align the incisal edges.

When MI Paste is applied immediately after microabrasion, a favorable change can be seen at the end of the same appointment.

Prof. Laurie Walsh

After applying MI Paste each evening for one week, the final appearance shows further improvements in surface texture and more even reflections, giving a lighter appearance without a whitening treatment.

SUMMARY

MI Paste can enhance the appearance of teeth after orthodontic debanding once all residue bonding resin has been removed. A nightly, at home application will also give the teeth a lighter appearance.

AREAS OF ENAMEL WHICH ARE HYPOMINERALIZED

The strategy of enamel subsurface regeneration can be applied to some cases of enamel hypomineralization where impaired enamel formation results in the accumulation of water in voids within the enamel, causing opacity. In cases where the lesions are poorly defined, the use of MI Paste can provide a useful improvement in the patient's appearance following a very conservative treatment approach.

As with fluorosis, it is important to maximize the microscopic porosity of the enamel surface overlying the defect, by etching combined with gentle microabrasion. MI Paste is then applied immediately and the patient continues to apply it each evening immediately before bed. The treatment sequence can be repeated several times (e.g. with appointments spaced several weeks apart) to gain a greater effect.

MI Paste is not a panacea for all areas of disordered enamel. Demineralized enamel can be treated with phosphoric acid microabraded and then MI Paste applied. If the areas are superficial and shallow, regeneration will result in the complete removal of the defect. Well demarcated areas will respond relatively poorly, however diffused poorly demarcated areas are more shallow and will respond better.

In this patient, there are enamel lesions caused by hypomineralization limited to the incisal third of the labial enamel of the two maxillary central incisors. The lesions are poorly demarcated, which is a positive sign as it suggests a shallow depth and thus a greater effect from the treatment.

Clinical Case

A conventional 37% phosphoric acid gel is applied to the lesions and the surrounding normal enamel for one minute.

After surface conditioning, the surface is more porous.

After four weeks of nightly application of MI Paste, the visible appearance of the lesions has reduced.

Prof. Laurie Walsh

After six weeks the effect is even more pronounced.

SUMMARY

When there are poorly demarcated labial surface lesions, treatment with MI Paste is indicated. These individual areas can be covered with phosphoric acid gel for 15 to 30 seconds, then microabraded and MI Paste applied immediately. The patient should then be instructed how to use MI Paste at home, either daily or twice daily. Only then can complete reversal in these areas be predictably achieved.

TREATMENT OF FLUOROSIS AFTER BLEACHING

Clinical Case

In patients who have had their teeth bleached, any existing fluorosis will tend to become more obvious since excessive use of bleaching treatments increases the loss of protein in enamel, and therefore increases the water content, making the enamel become more opaque. For this reason, it is not uncommon to notice fluorosis more once teeth have been bleached.

Because bleaching treatments increase the porosity of the enamel, etching is not required and the simple application of MI Paste each night after bleaching will create the required changes in the subsurface mineral causing the complete elimination of the fluorosis.

This clinical case shows a difficult case of fluorosis on a 26 year old patient that required two in-surgery power bleaching appointments one month apart. MI Paste was recommended prior to treatment to reduce sensitivity often experienced during this procedure and to give an improved final result. In between appointments MI Paste was applied twice daily.

» Before whitening.

» Immediately after the initial whitening appointment with heavy white staining on teeth still apparent.

Mr C. Müller

» Two weeks after final whitening appointment and twice daily application of MI Paste.

SUMMARY

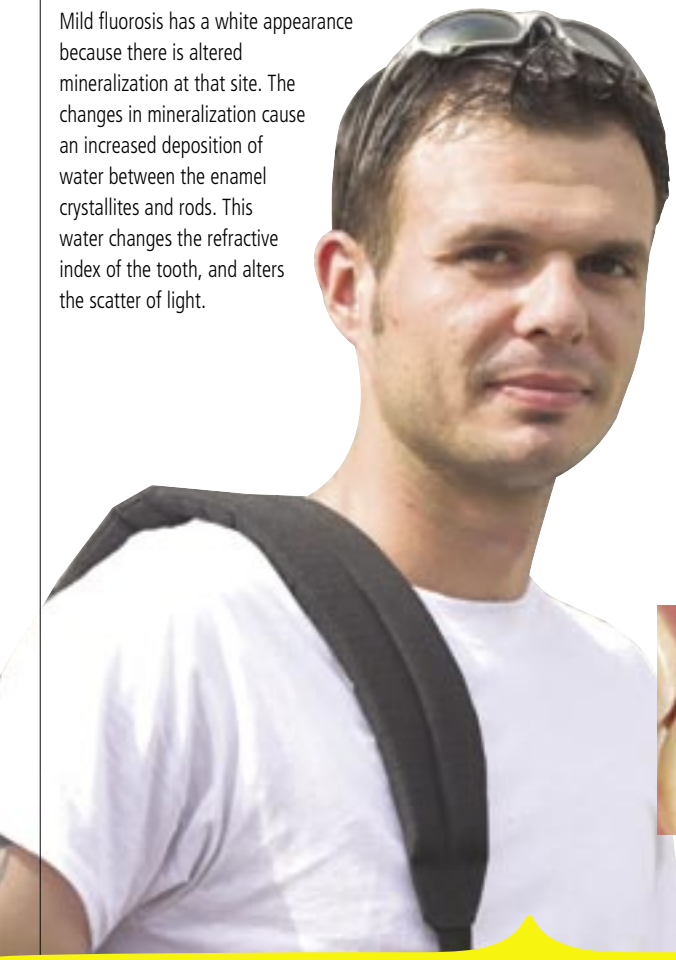
Bleaching treatments increase the porosity of the enamel, therefore etching is not required and the simple application of MI Paste twice daily after bleaching will create the required changes in the subsurface mineral causing the complete elimination of the fluorosis.

TREATMENT OF FLUOROSIS

The main difference in clinical protocol when using MI Paste as a treatment material is the preparation technique required for fluorosis. It is necessary to first pre-treat the lesion to make the area porous before applying the MI Paste. This pre-treatment involves using acid etching and microabrasion.

Dramatic reductions in enamel opacity of fluorotic teeth can be achieved by using MI Paste after appropriate preparation of the enamel surface by micorabrasion.

Mild fluorosis has a white appearance because there is altered mineralization at that site. The changes in mineralization cause an increased deposition of water between the enamel crystallites and rods. This water changes the refractive index of the tooth, and alters the scatter of light.



Clinical Case

The pre-treatment view shows mild fluorosis with "snow-capped" anterior teeth.

At the end of the first appointment, three cycles of etching/microabrasion have led to a reduction in the area of the opacities. A two minute etching time was used for each cycle.

Prof. Laurie Walsh

After four weeks of nightly application of MI Paste, the remaining opacities have been replaced by enamel with a normal optical appearance.

Before and after treatment

SUMMARY

In many cases of mild fluorosis, a single treatment sequence of etching/microabrasion followed by a nightly application of MI Paste can achieve the desired result. Patients should be advised that the visual effect occurs through a slow chemical reaction, and thus should expect to see changes over several weeks rather than instantly.

TREATMENT OF FLUOROSIS

Clinical Case

Using the process of subsurface remineralization, it is possible to reverse the visible appearance of fluorosis. In this clinical case, the pattern of fluoride-related opacity is particularly marked on the incisal edges and the proximal enamel.

As the penetration of ions into tooth structure is limited by diffusion, a surface preparation step is important to gain the greatest effect when using MI Paste. Etching with an acid gel removes surface pellicle and makes the superficial enamel more porous, allowing ions to penetrate into the subsurface region. When using phosphoric acid, a concentration of 30-40% is adequate both for this surface conditioning and for routine enamel etching. However, in cases of fluorosis, the etching time must be increased as the greater content of fluorapatite makes the enamel mineral more acid resistant. A maximum etching time of 1.5-2 minutes (per cycle) is recommended in such cases.

It is important to remember that increasing the concentration of phosphoric acid is not a useful means for reducing the etching time, since concentrations above 50% applied to enamel cause the formation of a monocalcium phosphate monohydrate material – which inhibits further dissolution of enamel*.

In other words, etching of enamel with 65% phosphoric acid would be less effective than 35% in terms of achieving a more porous surface prior to applying MI Paste, or for bonding of composite resin materials.

*Gottlieb EW, Retief DH, Jamison HC: An optimal concentration of phosphoric acid as an etching agent. Part I: Tensile bond strength studies. J Prosthet Dent 48: 48-51, 1982.

Obvious opacities from fluorosis.

A two minute etch with 37% phosphoric acid gel is undertaken, followed by gentle surface microabrasion with fine pumice in a conventional prophylaxis handpiece at 1000rpm rotational speed.

After three weeks of applying MI Paste each evening before bed, a reduction in the enamel opacity can be seen.

Prof. Laurie Walsh

After seven weeks of the same treatment, the opacities have been converted to normal translucent enamel.

SUMMARY

Surface preparation of tooth structure is important if the best result is to be obtained. Etching with an acid gel makes the superficial enamel more porous allowing ions to penetrate the subsurface region. Apply MI Paste daily before sleeping and leave the residue in place overnight.

IMPROVING THE APPEARANCE OF ENAMEL

When considering the appearance of enamel surfaces, the pattern of surface reflection should be examined. In many patients, subtle grooves and other surface undulations on the labial surfaces of the incisor teeth cause diffuse scattering of light. Modifying this pattern can cause greater mirror-like (specular) reflection of the incident light from the labial surfaces. In simple terms, greater reflection of light makes the teeth appear lighter, so it is appropriate to describe this surface effect as tooth 'lightening' effect, as opposed to 'whitening' where the intent is to reduce internal tooth discoloration.

The procedure of tooth lightening has some similarities to polishing restorations, except that the levels of micro-roughness are different. In its natural state, the labial enamel surface has many irregularities at the microscopic scale. It is also covered by pellicle. To obtain the smoothest surface at the microscopic level, the first stage of the treatment involves etching for 30 seconds and gentle microabrasion. This can be repeated to obtain the desired level of surface optical change. In some cases, graded abrasive pastes or conventional polishing discs can then also be used with good effect. Salivary promoted enamel remineralization occurring immediately after treatment can be greatly enhanced by application of MI Paste. Continued daily use of MI Paste as part of a home care regimen will optimize the tooth 'lightening' session.

One of the important benefits of using MI Paste in the treatment protocol is to maximize the quality of the surface enamel, making it more resistant to subsequent acid attacks. By elevating calcium levels in the saliva and within dental plaque, the material can reduce the critical pH for dissolution of enamel minerals, making the teeth less prone to erosion. This is particularly important for the maxillary incisor teeth as their labial surfaces do not receive the benefits of extended contact with saliva, and are thus prone to mineral loss from erosion.

Clinical Case

» This shows the initial situation.

» Immediately after three cycles of enamel etching and gentle microabrasion, with the teeth having been dried thoroughly. The pattern of vertical grooving is less obvious, and a gentle etching pattern can be seen on the teeth. MI Paste can be applied immediately after this stage. The casein phosphopeptide proteins will bind to the enamel surface and the teeth will feel smooth.

Prof. Laurie Walsh

» At the review appointment four weeks later, the enamel surface has remineralized and the change in reflection is very apparent. The labial surfaces of the maxillary central incisors now give a mirror-like reflection of the incident (incoming) light. In such cases, the final visual effect is normally evident after the second or third week.

SUMMARY

This clinical case was a first for MI Paste, but had a very satisfying outcome with a home care treatment program of a nightly application of MI Paste before bed for a period of four weeks.

In patients with low resting salivary pH, the enamel can dissolve into the oral fluids and as a result the exposed dentin then lacks a smear layer, and is extremely sensitive with open tubules as can be seen here. When Recaldent™ (CPP-ACP) is applied onto the surface of this dentin, the protein component bonds strongly and subsequently mineral plugs form, which begin to block the tubules. Several clinical studies have shown that MI Paste has a potent long acting desensitizing effect when used in patients with cervical sensitive dentin.

Three recent clinical studies conducted at the University of Queensland and completed in 2006 followed the symptom pattern in groups of patients with long standing cervical dentinal hypersensitivity (CDH). As part of the first study, 18 patients applied MI Paste each night before retiring. Compared with the baseline values, CDH scores were reduced significantly at four weeks on average by 47%, and at six weeks by 57%[1].

In a second study, 31 patients used the same home treatment protocol, as in the first study, for six weeks, and then stopped treatment with MI Paste completely. Importantly, this wash-out study showed that the reduction of sensitivity achieved (on average 31%) was maintained during the next four weeks, indicating an effect on the cause of CDH as well as the symptoms[2].

In the third study, a group of ten patients with long standing salivary dysfunction and associated symptoms of CDH were followed over 12 months. There was a dramatic reduction in symptoms after one month, and this effect was maintained over the ensuing months up to one year, with a sustained reduction on average of 38%. There was evidence of an accumulating effect over time, from the first month onwards[3].

Prof. Laurie Walsh

Obtaining a long term solution to cervical dentinal hypersensitivity and dental erosion was a major challenge before the development of Recaldent™ (CPP-ACP) technology.

1. Walsh LJ et al. *Effect of CPP-ACP versus potassium nitrate on cervical dentinal hypersensitivity*. J Dent Res 2006; 85 (Spec Iss A): 0947.

2. Bird K, et al. *Comparative efficacy of two dentinal sensitivity treatment modalities: A 10 week study*. Unpublished research report, University of Queensland, 2006.

3. Vlacic J. *In vivo and in vitro investigations of laser and non-laser therapies in treatment of root surface erosion and root surface caries*. PhD thesis, University of Queensland, 2006.

SUMMARY

MI Paste with Recaldent™ (CPP-ACP) applied at least once daily provides both immediate and long term solutions to the common problem of dentinal hypersensitivity. It can arrest the process of dental erosion which is a common underlying cause of chronic tooth sensitivity.

SENSITIVITY AND EROSION

In patients with gastric reflux disease, the extensive loss of tooth mineral and tooth structure can present a major challenge to successful treatment. MI Paste is able to assist remineralization even under conditions of low (acidic) pH, which makes it very useful for patients with reflux disease.

The clinical case shown on the right presented with extensive non-carious loss of tooth structure desiring an improvement in function and appearance. Many teeth had become worn, chipped and very sensitive over recent months. The erosive lesions showed the characteristic pattern of palatal destruction of the anterior teeth. Careful questioning revealed the patient had suffered from gastric reflux for some years, although the condition had recently become worse because of use of a non-steroidal anti-inflammatory drug for an arthritic condition.

The management approach taken was to seek medical intervention from the patient's general medical practitioner and to commence a home care program comprising MI Paste applied each night, in combination with sodium bicarbonate mouth rinse after each meal and again after any episodes of reflux. This treatment quickly reduced the symptoms of sensitivity from the exposed dentin, and began the process of regaining mineral into the depleted tooth structure.

After six weeks on the home care program, direct build-ups were undertaken using glass ionomer and composite resin, retaining all of the existing tooth structure. The canines were restored initially to establish the occlusal vertical dimension, followed by careful build-up of the remaining anterior and then posterior teeth.

This treatment has enabled conservation of the existing tooth structure, with restoration of aesthetics and function. MI Paste is an essential component for reversing the disease process and creating a sound foundation for future restorative work.

Clinical Case

» Many teeth were worn, chipped and very sensitive. The erosive lesions showed the characteristic pattern of palatal destruction of the anterior teeth.

» The home care program comprised an application of MI Paste each night, in combination with sodium bicarbonate mouthrinses after each meal and again after any episodes of reflux.

Prof. Laurie Walsh

» After six weeks on the home care program, direct build-ups were undertaken using glass ionomer and composite resin, retaining all of the existing tooth structure.

SUMMARY

MI Paste can be used for patients with dental erosion and aggressive tooth wear, where the tooth surfaces have become sensitive. MI Paste is indicated for patients who have gastro esophageal reflux disease or eating disorders where the patient is vomiting. Because of the low pH of gastric contents, there is only limited ability to achieve any remineralization with fluoride alone. This is because of the lack of saturation with calcium and phosphate. A twice daily application of MI Paste helps overcome this problem.

SENSITIVITY AND EROSION FROM WINE AND CARBONATED SOFT DRINKS

INFORMATION AND ADVICE FOR WINE TASTERS
BY DR. GILBERT LABOUR, MAWSON ACT

Wine is acidic, especially dry white wines such as Rieslings and Semillons and white wines are more erosive than red wines, although the latter stain the tongue and teeth more. However sparkling white wines are the most acidic and erosive of all.

Dental erosion means the irreversible loss of hard dental tissues by acid, either from intrinsic sources such as gastric reflux, regurgitation and vomiting, or from extrinsic diet-related sources such as wine, citric fruit juices, soft drinks and sports/energy drinks.

Treatment demands both a reparative and a preventive approach. Once an acceptable level of dental health and hygiene has been restored, a maintenance and preventive program is essential.

MAINTENANCE WOULD USUALLY INVOLVE:

- regular use of a high fluoride-containing toothpaste
- use of a concentrated topical fluoride gel before and after tasting sessions
- use of Recaldent™ chewing gum which will also help in increasing saliva flow
- use of MI Paste to help build a protective film
- wearing of a night guard if necessary to reduce the damage done by bruxing.

Paraphrased with permission of the author Dr. Gilbert Labour from an article published in the Australian & New Zealand Wine Industry Journal.

SUMMARY

Currently there is a range of Recaldent™ chewing gums in adult and children's flavors, as well as MI Paste. Use these products together with topical fluoride and fluoride mouthwashes in order to maximize the longevity of the teeth. Recaldent™ gum is very handy and beneficial between tastings of white wines as it immediately raises the pH of acidic saliva, making it difficult for plaque to adhere to tooth surfaces.

DENTAL EROSION DURING PREGNANCY

MI Paste can be used to arrest dental erosion. Once this has been achieved, the teeth which are now not sensitive can be restored using adhesive restorative methods or full coverage restorations as needed.

In patients with quite marked dental erosion from salivary gland disease, gastro esophageal reflux disease and other similar problems, MI Paste can be used for desensitizing and remineralizing, and then restorations placed as needed.

During pregnancy, hormonal changes result in a dramatic decrease in the buffering capacity of the saliva. At the same time, nausea from morning sickness can lead to frequent reflux of low pH acidic contents of the stomach, particularly in the second and third months of pregnancy. Reduced protection from saliva, combined with frequent acid challenges, means that many pregnant women are at high risk of demineralization during pregnancy. Without additional protection of tooth structure, frequent reflux can lead to loss of enamel and exposure of sensitive dentin. This typically begins on the palatal surfaces of the maxillary incisor teeth, adjacent to the palatal gingival margins.

Regular use of MI Paste during pregnancy helps to maintain elevated levels of calcium and phosphate in the saliva, protecting the teeth from dental erosion. There is also an additional benefit because MI Paste will inhibit the growth and adhesion of mutans streptococci, which would otherwise flourish in an acidic oral environment.

Prof. Laurie Walsh

SUMMARY

A daily application of MI Paste will help sooth sensitive teeth and protect areas of exposed dentin. Reducing levels of mutans streptococci is important during pregnancy since high levels increase the chance of transmission to the newborn child from transient salivary contact.

BABIES

Newly erupted teeth have yet to complete their enamel maturation and until this occurs they are more vulnerable to acid attack. Boosting levels of calcium and phosphate in the saliva facilitates the normal post-eruption maturation process and replaces mineral loss on a daily basis. Recaldent™ (CPP-ACP) is derived from cow's milk and is ideal for protecting deciduous teeth at a time when oral care is difficult.

Prof. Eric Reynolds

CPP-ACP attaching itself to mutans streptococci.

JUNIORS

For youngsters with white spot lesions on deciduous teeth, brush with a low fluoride toothpaste (400-500 ppm) specially designed for children and then apply a nightly coating of MI Paste using the finger to cover the white spots and leave in situ while sleeping.

For children with early childhood caries, MI Paste can be used nightly before sleeping. A weekly application of 0.2% chlorhexidine gel will also help to decrease bacterial growth and reduce the incidence of caries lesions.

As soon as all the teeth are fully erupted there are many choices to keep fissures protected from acid attack, such as sealants, MI Paste and dietary control of carbohydrate intake. Starting early means healthy teeth and a healthy lifestyle for the future.

SUMMARY

Regular MI Paste is fluoride free and is especially useful for children under the age of 6, where toxicological issues mean normal or high strength fluoride products are contraindicated. MI Paste is applied to the teeth twice daily with the finger to provide a surface film that will raise levels of essential minerals (calcium and phosphate), as well as inhibit the growth of caries causing bacteria. MI Paste is a safe product to use for babies' teeth, is well tolerated by children and tastes delicious.

CARIES STABILIZATION

Clinical Case

For patients who have dramatic caries, MI Paste can stabilize the oral environment while lifestyle changes are being undertaken. The teeth of patients with severe caries and tooth wear can be remineralized very rapidly and then conservative restorations placed without removing significant amounts of tooth structure to restore the patient's comfort function and aesthetics. Even in patients with aggressive caries, the use of home care measures including MI Paste can arrest the caries disease process and these patients can then be treated for long term stability.

MI Paste can be useful for enhancing levels of calcium and phosphate in saliva, dental plaque and tooth structure. In so doing it can aid in arresting the progression of caries and can improve the substrate for adhesive dental restorations.

The patient opposite works as a rigger on large building projects. His lifestyle has a number of risk factors for dental disease, including dehydration from working outdoors in a hot climate, and a high daily intake of black cola soft drinks. He has recently become engaged and is seeking to improve his appearance as part of his preparations for the wedding. His maxillary incisors are broken down from caries, with tooth 21 previously having root canals. The patient has recently given up smoking and has become more aware of oral health issues.

Saliva testing was used to motivate and improve his lifestyle. Given the significant destruction of the incisors, it was important to conserve tooth structure when planning for their eventual restoration. MI Paste was prescribed each night before bed, to aid in the arrest of the caries process, and to increase levels of mineral in the exposed dentin. There were ongoing concerns as to the extent of occupation-related dehydration, so it was decided to maintain his MI Paste treatment until all of his restorative care was completed. His intake of black cola soft drinks was reduced by substitution with water, and this lifestyle change improved his resting salivary parameters.

Some three weeks after commencing the stabilization routine, the teeth were prepared using minimal intervention principles, removing soft infected dentin but without following a preconceived outline form. A fast setting glass ionomer was used to cover the gutta percha in tooth 21. The dentin was covered with resin-modified glass ionomer cement and then overlaid with composite resin, to give a pleasing natural appearance.

MI Paste applied each night before bed.

The teeth were prepared three weeks after commencing the stablization process.

Prof. Laurie Walsh

The dentin was covered with resin-modified glass ionomer cement, then overlaid with composite resin, to give a pleasing natural appearance.

SUMMARY

A twice daily application of MI Paste will rapidly stabilize the situation. A change of lifestyle is important to ensure ongoing treatment will be successful. In order to ensure longevity of restorations after treatment, continued daily use of MI Paste is recommended.

ROOT SURFACE CARIES

For patients with aggressive root surface caries and periodontal problems caused by medical conditions such as diabetes mellitus, MI Paste is essential for long-term stability of the exposed root surfaces. This is also true for patients with primary Sjögren's syndrome where the root surfaces can be stabilized. The patient can use the MI Paste or MI Paste Plus in combination with GC Dry Mouth Gel.

Elderly patients with salivary dysfunction (dry mouth) linked to their medical conditions or their medications can undergo a rapid increase in the risk of both coronal and root surface caries. By elevating levels of calcium in saliva and dental plaque, MI Paste can reduce the harmful effects of plaque-derived acids and drive remineralization.

Clinical Case

This patient has type II diabetes mellitus, active caries and untreated periodontitis. His diabetic condition was undiagnosed until recently, and was a major contributor to his impaired salivary flow rates.

After instituting a home care program to promote remineralization and a series of appointments for periodontal debridement and restorative work, the situation has improved. Daily use of MI Paste, used in conjunction with a triclosan-releasing toothpaste (Colgate Total™) and flossing, is a useful protocol for this patient's home care over the long term.

Prof. Laurie Walsh

The primary root surface caries lesion on the buccal aspect of tooth 27 has hardened and undergone arrest. It is free of plaque and is not likely to breakdown in the future as it is now hypermineralized.

SUMMARY

A minimum twice daily application of MI Paste or MI Paste Plus will greatly assist special needs patients. GC Dry Mouth Gel will also be useful to provide lubrication throughout the day and night for patients suffering from xerostomia and Sjögrens syndrome.

ROOT SURFACE CARIES

The dramatic destruction of this patient's maxillary teeth occurred because of caries, and the maxillary incisors have cervical caries. An acidic oral environment has allowed overgrowth of cariogenic bacteria and caries has progressed most rapidly in areas with limited salivary defense. This explains why the mandibular incisor teeth are unaffected. Direct chairside measurement of acid production by plaque was undertaken using the GC Plaque-Check +pH test kit.

After introducing the patient to a home care program of fluoride and MI Paste to help facilitate remineralization, the caries process has been halted and the hardness of the dentin has increased.

Home care consisted of a minimum twice daily brushing with a high fluoride containing toothpaste (5000 ppm), a weekly application of chlorhexidine gel and twice daily application of MI Paste. Eight weeks later interim restorations were placed, using a high strength glass ionomer overlaid with composite resin on both incisor teeth. Increasing the levels of mineral in the dentin is essential to maximize the chemical bonding of glass ionomer materials.

A hostile acid environment and overgrowth of cariogenic bacteria has caused major tooth destruction.

Prof. Laurie Walsh

After an eight week intensive home care program, interim restorations have been fabricated.

SUMMARY

In patients with a high rate of root surface caries, a twice daily application of MI Paste helps to address the underlying problems of poor salivary parameters at rest and can prevent the caries from effecting the remaining structure of the teeth. Chlorhexidine gel and a high fluoride containing toothpaste are essential to help stabilize this situation.

Clinical Case

Several uses for MI Paste are illustrated for Sam, a 25 year old patient suffering from acute Leukemia. He went to the emergency department of his local hospital complaining of severe malaise, lethargy and spontaneous bleeding. In addition he had noticed a rapidly developing gingival enlargement over recent weeks and the gingival tissues had become extremely prone to bleeding, to the point where he had stopped all mechanical oral hygiene.

Extensive cervical white spot carious lesions developed during hospitalization for chemotherapy over a period of four months. Other contributing factors leading to the development of caries included Sam's inability to brush his teeth (due to severe oral ulcerations from the chemotherapy), high carbohydrate diets (to maintain nutrition), and the side effects of anti-emetic and other medications. During chemotherapy, an application of MI Paste was used to prevent erosive damage to the teeth from nausea, and to alleviate discomfort from areas of oral ulceration that develop as a side effect of neutropenia and bone marrow suppression.

» Gingival tissues are extremely prone to bleeding.

Prof. Laurie Walsh

» Extensive cervical white spot carious lesions developed during hospitalization for chemotherapy.

Prof. Laurie Walsh

MI Paste was used to alleviate discomfort from oral ulceration.

SUMMARY

Following head and neck radiation treatment, MI Paste is recommended twice daily for use in a home care program with chlorhexidine gel and a suitable fluoride toothpaste. Using a 5000 ppm fluoride toothpaste once per day, ideally midmorning or midday, apply chlorhexidine a minimum of 30 minutes before brushing with the fluoride toothpaste. If possible, leave any residual MI Paste in the mouth overnight to provide additional protection.

This very effective technology is safe and ingestible. Recaldent™ (CPP-ACP) has been classified by the United States Food and Drug Administration as GRAS (generally recognized as safe). This means it is safe to swallow and can be used in patients of all ages.

Recaldent™ (CPP-ACP) is milk derived with lactose content less than 0.01%. It should not be used in patients who have a milk protein allergy. Patients who have an allergy to benzoates or some other components should also not use the material.

MI Paste & MI Paste Plus is available in five delicious flavors:

Melon, Mint, Strawberry, Tutti-Frutti and Vanilla

- For children under the age of 6 it is recommended to use MI Paste with Recaldent™ (CPP-ACP), it does not contain fluoride.
- MI Paste Plus with Recaldent" (CPP-ACP) and Fluoride is recommended for patients 6 years and older. MI Paste Plus is not recommended for patients under the age of 6.
- MI Paste Plus offers the same great benefits of regular MI Paste, enhanced with 0.2% sodium fluoride to further promote remineralization and protect teeth from caries development.
- MI Paste Plus is the only product that provides the correct bio-available ratio of: 5 - calcium, 3 - phosphate, 1 - fluoride. The same ratio that is found in healthy enamel.
- Caution: Casein phosphopeptides are derived from milk casein. Do not use the material on patients with a proven or suspected milk protein allergy and/or with a sensitivity or allergy to benzoate preservatives.

CONTENTS

* Note GC MI Paste™ / GC MI Paste Plus™ and GC Tooth Mousse® and GC Tooth Mousse Plus® are synonomous. In the United States it is called MI Paste or MI Paste Plus. In Australia it is called Tooth Mousse or Tooth Mousse Plus.

ACID RESISTANCE OF REMINERALIZED ENAMEL BY A SUGAR-FREE CHEWING GUM

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OBJECTIVES

This study examined the effect of a sugar-free chewing gum (Tablet type) containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP; Recaldent™, CASRN: 691364-49-5) on an acid resistance of remineralized enamel without fluoride conditions in a human in situ model.

METHODS

Twenty subjects in randomized, cross-over, double-blind studies wore removable mandibular appliances with a demineralized human enamel sample. The appliances were inserted in oral environment immediately before gum-chewing for 20min and then retained for another 20min. This was performed four times per day for 14 days. Intra-oral experiment using another gum was performed after one week of washout time. Half of the enamel samples were covered with nail varnish after intra-oral exposure for remineralization. The enamel samples were acid challenged for three days in vitro, sectioned and subjected to microradiography to determine the level of mineral vol%.

RESULTS

During the second acid challenge, the mineral loss level of CPP-ACP tablet gum group showed less mean mineral loss (-2142) than that of placebo gum (-2804). The difference between the two groups was statistically significant and the probability was 0.036. The reason why there was a less mineral loss during the second acid attack for three days in case of CPP-ACP gum, it seems that this gum remineralizes subsurface enamel with mineral of higher crystallinity than saliva. The formation of higher crystallinity makes the mineral less soluble in acid.

CONCLUSION

Remineralized enamel by CPP-ACP tablet gum was much higher acid resistant than placebo gum.

REMINERALIZATION OF WHITE SPOT LESIONS IN SITU BY TOOTH MOUSSE

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OBJECTIVES

To investigate the potential of a commercially available dental crème containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), ["GC Tooth Mousse" (10% w/v CPP-ACP) (GC Corp, Japan)] to remineralize sub-surface white spot lesions of enamel (WSL) in a double blind, randomized, 2-way cross-over in situ study.

METHODS

Enamel specimens were sectioned from either buccal or lingual surfaces of extracted sound human third molars and WSL windows were created using the Carbopol method. Specimens were divided into test and control half slabs. Healthy volunteers (n=6) wore mid-palatal appliances containing four enamel test slabs with WSL. A slurry (1g crème, 4ml H_20) of Tooth Mousse (TM $_{test}$) or placebo Tooth Mousse (TM $_{Placebo}$) was placed intraorally (60s) after appliance insertion. The appliance was worn (40min) and the process repeated four times per day for 10d. Cross-over occurred after a 7d washout. Mineral content of each remineralized half-slab invested in resin with its control half slab was determined by microradiography after sectioning and lapping to 85 ± 5µm. The % mineral profiles of each WSL and adjacent sound enamel were compared and differences between sound and lesion values calculated (ΔZd, ΔZr). Proportional change in mineralization (%R) was calculated according to the formula: $\%R = ((\Delta Zd - \Delta Zr)/\Delta Zd) \times 100$ and data analysed (ANOVA, Tukey's post-hoc, $p<0.05$).

RESULTS

TM $_{Placebo}$ resulted in a %R of 3.72 ± 2.10%, whereas TM $_{test}$ produced %R of 24.22 ± 3.31%.

CONCLUSION

A 20% dilution of GC Tooth Mousse crème containing CPP-ACP produced 551% more WSL mineralisation than a placebo crème in an in situ model.

This study was supported by the Cooperative Research Centre for Oral Health Science, School of Dental Science, The University of Melbourne.

REMINERALIZATION BY A MOUTHRINSE CONTAINING CPP-ACP AT pH 5.5

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OBJECTIVES

To investigate the efficacy of mouthrinse containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) at pH 5.5 in remineralization of enamel subsurface lesions in an human in situ model.

METHOD

This study utilized a double blind, cross-over design with two treatments: (i) a mouthrinse containing 0.5% CPP-ACP at pH 7.0 and (ii) a mouthrinse containing 0.5% CPP-ACP at pH 5.5. Subjects wore removable palatal appliances with four human-enamel half-slabs inset containing subsurface demineralized lesions. The subjects were instructed to rinse with 5ml of mouthrinse for 60 seconds four times a day (at 10:00am; 11:30am; 2:00pm and 3.30pm) for ten consecutive days. The subjects did not wear the appliances during eating, drinking and oral hygiene procedures. There was a one-week washout period after which the subjects crossed over to the other mouthrinse. After each treatment period the enamel slabs were removed, paired with their respective demineralized control, embedded, sectioned and subjected to microradiography and computer-assisted densitometric image analysis to determine the level of remineralization.

RESULTS

Use of the mouthrinse containing 0.5% CPP-ACP at pH 5.5 produced 14.2 ± 1.9% remineralization of the enamel subsurface lesions in the 10 day period whereas the pH 7.0 rinse resulted in a 10.3 ± 2.3% enamel subsurface remineralization.

CONCLUSION

A 0.5% CPP-ACP mouthrinse at pH 5.5 produced significantly greater (38%) remineralization in situ than a 0.5% CPP-ACP rinse at pH 7.0.

REMINERALIZATION BY CHEWING GUM CONTAINING CPP-ACP AND CITRIC ACID

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OBJECTIVES

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) have been shown to remineralize enamel subsurface lesions in situ. The aim of this study was to investigate the effects of CPP-ACP in a fruit-flavoured sugar-free chewing gum containing citric acid on enamel remineralization, and the acid resistance of the remineralized enamel, using an in situ remineralization model.

METHOD

The study utilized a double blind, randomized, crossover design with three treatments: (i) sugar-free gum (two pellets) containing 18.8mg CPP-ACP and 20mg citric acid, (ii) sugar-free gum containing 20mg citric acid alone, and (iii) sugar-free gum not containing CPP-ACP or citric acid. Ten subjects were instructed to wear removable palatal appliances, with four half-slab insets of human enamel containing demineralized subsurface lesions, and to chew gum (two pellets) for 20min (4 times/d, 14d). At the completion of each treatment the enamel half-slabs were removed and half of the remineralized lesion treated with carbopol/lactic acid for 16hr. The enamel slabs (remineralized, acid challenged and control) were then embedded, sectioned and subjected to microradiography to determine the level of remineralization.

RESULTS

Chewing with the gum containing CPP-ACP and citric acid resulted in significantly higher remineralization (13.1% ± 2.2%) than chewing with either the gum containing no CPP-ACP or citric acid (9.3% ± 1.2%) or the gum containing citric acid alone (2.6% ± 1.3%) ($p<0.01$). The 16hr acid challenge of the remineralized lesions showed that the level of mineral after acid challenge was significantly greater for the gum containing CPP-ACP and citric acid when compared with the other two gums ($p<0.01$).

CONCLUSION

Sugar-free chewing gum containing CPP-ACP and citric acid significantly promoted remineralization of enamel subsurface lesions in situ.

REMINERALIZATION POTENTIAL OF CPP-ACP AND ITS SYNERGY WITH FLUORIDE

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OBJECTIVES

To evaluate the remineralization potential of casein phosphopeptide - amorphous calcium phosphate (CPP-ACP) in a tooth creme and its synergy with fluoride.

METHODS

This cross-over in situ model involved five healthy adult subjects and four randomized treatments: tooth creme containing 10% CPP-ACP, (Tooth Mousse GC Corporation; TM), creme containing 10% CPP-ACP plus 900ppm Fluoride (TMP), placebo creme without CPP-ACP and fluoride, and a professional paste containing 950ppm fluoride. Enamel subsurface lesions (2.5 x 1 mm2) on polished bovine tooth slabs (10 x 5 x 1 mm3) were created by exposure to a lactic acid gel (0.1 M, pH 5.1 with 3 mM $CaCl_2$, 1.8 mM KH_2PO_4 and 5% HEC) at 37 degree Celsius for five days. The slabs were then mounted in a buccal flange on a removable maxillary appliance (4 lesions/appliance). Subjects were instructed to brush their teeth after lunch with a fluoride toothpaste (900ppm), cover the lesions with the tooth creme, wear the appliance for 30min, rinse the lesions with water, and keep the appliance in the mouth for four more hours. This was repeated every day for seven days. The appliance was kept in a humidified environment when outside the mouth. The lesions were subjected to analysis using an X-Ray CT scanner (TOSCANER-30000mhd, Toshiba) and Scion Image for Windows before and after intraoral treatments.

RESULTS

The mean percentage remineralization for the placebo, fluoride paste, TM, TMP was 5.76 ± 10.13, 12.14 ± 14.17, 12.73 ± 11.80, and 27.07 ± 14.57 respectively. TMP was superior to all other formulations ($p < 0.01$).

CONCLUSION

This study demonstrated significant subsurface enamel remineralization by CPP-ACP tooth creme in the mouth, with a synergistic effect of CPP-ACP and fluoride.

QLF AND TMR ANALYSIS OF CPP-ACFP REMINERALIZED ENAMEL IN VITRO

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Casein phosphopeptides (CPP) have been shown to stabilise amorphous calcium phosphate (CPP-ACP). CPP-ACP has been associated with anticariogenicity and remineralization in in vitro and in vivo models. CPP has also been shown to stabilise amorphous calcium fluoride phosphate (CPP-ACFP) which had an additive effect compared with the separate remineralization effects of fluoride or CPP-ACP.

OBJECTIVES

The aim of this study was to examine the remineralization potential of two concentrations of CPP-ACFP in terms of mineral and visual change. The mineral formed was subsequently analysed using wavelength dispersive microprobe spectrometry.

METHODS

Enamel subsurface lesions were created using the Carbopol method and remineralized using CPP-ACFP solutions (0.5, 1.0%w/v) at pH 5.5 (2mL, 37°C, ten days, daily solution changes, n=10 lesions per group). The lesions were then digitally photographed, analysed using quantitative light induced fluorescence (QLF) to determine percentage fluorescent loss integrated over area (%Q), embedded, sectioned, lapped and analysed using transverse microradiography (TMR) to determine percentage mineral change (%R). Elemental maps and quantitative line scans for calcium, phosphorous, fluoride, oxygen and chlorine were collected across the lesions using wavelength dispersive spectrometry on a JEOL 8900 SuperProbe Microprobe.

RESULTS

The 0.5 and 1% CPP-ACFP solutions both produced statistically similar levels of remineralization as measured by TMR and QLF respectively, however there was more variation in the 0.5% lesions.

	0.5%	1%	P value
%R	56.3±17.7	58.7±5.9	0.85
%Q	83.4±16.0	93.1±6.6	0.36

All white spot lesions became more translucent after remineralization treatment. Microprobe analysis of remineralized enamel showed a single calcium phosphate phase with the ratio matching apatite. Fluoride was found evenly throughout the body of the lesions supporting fluorapatite formation.

CONCLUSION

CPP-ACFP solutions remineralized enamel subsurface lesions in vitro by the deposition of fluorapatite increasing mineral content and improving translucency.

INCORPORATION OF CASEIN PHOSPHOPEPTIDE-AMORPHOUS CALCIUM PHOSPHATE INTO A TEMPORARY CEMENT

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OBJECTIVES

The presence of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) in a temporary cement may act as a surface modifying agent which alters the permeability of cut dentin beneath temporary crowns. This study was carried out to determine the viability of incorporating CPP-ACP into a zinc oxide non-eugenol temporary cement in terms of its effect on setting time, compressive strength and film thickness.

METHODS

The base and catalyst pastes of Freegenol™ (GC Int Corp, Tokyo, Japan) were weighed to a ratio of 1:4 and mixed with 0.5%, 1.0%, 2.0%, 3.0%, 4.0% and 8.0% w/v of CPP-ACP powder. Test conditions were conducted using ISO recommendations for setting time, compressive strength and film thickness for Type 1-Class 1 zinc oxide non-eugenol cements. Control specimens contained no CPP-ACP. Five specimens were used in each test group.

RESULTS

Addition of ≤1.0% CPP-ACP reduced the setting time but ≥3.0% CPP-ACP delayed it beyond the ISO requirements of ten minutes. Increasing amounts of CPP-ACP tended to reduce the compressive strength of Freegenol™ from a mean of 5 MPa for the 0.5% CPP-ACP to 3 MPa for the 8.0% test group. These values were in compliance with ISO recommendations of 35 MPa as the maximum for compressive strength. Film thickness measurements for all test groups complied with the recommended maximum of 25µm.

CONCLUSIONS

The incorporation of ≥3.0% w/v CPP-ACP into Freegenol™ would require the addition of an accelerator, due to its effect of delaying setting time beyond ISO recommendations. The addition of up to 8.0% CPP-ACP into Freegenol™ is otherwise viable in terms of its compressive strength and film thickness.

This study is supported by the NHMRC grant no:359318 and the Cooperative Research Centre for Oral Health Science.

INCORPORATION OF CASEIN PHOSPHOPEPTIDE-AMORPHOUS CALCIUM PHOSPHATE INTO GLASS IONOMER CEMENT

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OBJECTIVES

The incorporation of Casein phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP) into glass ionomer cement (GIC) fissure sealant may enhance the inhibition of demineralization and promote remineralization. The aim of this study is to investigate the effect of incorporating increasing concentrations of CPP-ACP into Fuji III fissure sealant (GC Int. Corp., Tokyo, Japan) on its physical properties.

METHODS

Setting time (ST), Compressive Strength (CS), Diametral Tensile Strength (DTS), Film Thickness (FT) and Flow values (FV) of Fuji III containing 0, 1, 3, 5, 7 and 10% CPP-ACP were tested following the International Organization for Standardization (ISO) specifications 9917:1991 and 6876:1986. Results were analyzed using one-way ANOVA and the Kruskal-Wallis tests.

RESULTS

The effect of incorporating up to 10% CPP-ACP into Fuji III on the values of ST, CS, DTS and FV remained within ISO recommendations. The values of CS and DTS decreased with a significant effect when 10% CPP-ACP was added; in addition to a prolonged ST. Fuji III containing 5% CPP-ACP failed the FT test.

CONCLUSION

There was no adverse effect following the incorporation of up to 10% CPP-ACP on the physical properties tested except on FT with 5% CPP-ACP.

This project is supported by The Cooperative Research Centre for Oral Health Science.

PREVENTION OF DEMINERALIZATION AROUND ORTHODONTIC BRACKETS IN VITRO

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OBJECTIVES

To investigate the effect of sodium fluoride (Colgate Neutrafluor 9000ppm) (NaF) and/or 10% casein phosphopeptide-amorphous calcium phosphate (Tooth Mousse™)(TM) on enamel demineralization adjacent to orthodontic brackets in-vitro.

METHODS

Forty enamel specimens were sectioned from the buccal or lingual surfaces of extracted sound third molar teeth. Twenty specimens had molar tubes bonded with composite resin (Transbond, 3M)(CR) and twenty bonded with resin-modified glass ionomer cement (Fuji Ortho, GC Corp)(RMGIC). A 2mm window for demineralization was painted with nail varnish. Specimens were randomly divided into four treatment groups: (1) Control; (2) TM, (3) TM/NaF (50/50 w/w), and (4) NaF. Specimens had treatment solutions placed around the bracket margins and were immersed inverted into a Carbopol demineralization solution at 37°C. Specimens exposed for 96 hours, with the demineralization and topical solutions changed four-hourly. Quantitative Light-induced Fluorescence (QLF) images were taken eight-hourly under controlled conditions. The difference in fluorescence (ΔF) between baseline and 96 hours was calculated. The proportional change in fluorescence (%F) was calculated according to the formula $\%F=\Delta F_{baseline}-\Delta F_{96hr})/\Delta F_{baseline}$ and analysed using ANOVA and Tukey's post-hoc($p<0.05$).

RESULTS

Demineralization occurred in all groups: Control (CR):ΔF:-6.69±0.89, %F:67.8±11.1%; Control (RMGIC): ΔF:-2.96±1.27%, %F:29.7±12.4 ; TM (CR) ΔF:-2.64±0.99%, %F:30.4±11.9%; TM (RMGIC): ΔF:-2.05±1.12; %F23.6±13.2; NaF (CR): ΔF:-1.96±0.89, %F:17.7±9.1%; NaF (RMGIC): ΔF:-2.16±0.56, %F:20.7±8.4%; TM/NaF (CR): ΔF:-1.9±1.77, %F:18.9±17.1; TM/NaF (RMGIC): ΔF:-0.81±0.31, %F:8.3±2.7%. RMGIC significantly reduced ΔF and %F when compared to CR (ANOVA, p= 0.029 and p=0.034 respectively). Control (CR) ΔF and %F were significantly greater when compared to all test materials (Tukey post-hoc, $p<0.001$). Control (RMGIC) ΔF and %F were significantly greater than TM/NaF (Tukey post-hoc, p=0.008, p=0.019 respectively).

CONCLUSIONS

TM, NaF and TM/NaF significantly reduced ΔF and %F in CR specimens when compared to the control. TM/NaF was superior to TM or NaF alone in reducing ΔF and %F in RMGIC specimens. The use of RMGIC significantly reduced ΔF and %F when compared to CR.

SALIVA, SALIVARY PEPTIDOME, AND ITS INTERACTION WITH CASEIN PHOSPHOPEPTIDES

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Milk products and saliva are both known to exhibit protective effects towards tooth enamel. Casein phosphopeptides (CPP), calcium and phosphate are responsible for the anticariogenic activity of dairy products, but the exact mechanism of activity and the interaction of CPP with salivary proteins have not been fully investigated. The integrity of tooth enamel is also maintained by the selective adsorption of salivary proteins that forms a protective barrier termed the enamel pellicle.

OBJECTIVES

To identify salivary pellicle proteins. To investigate the binding of CPP to salivary proteins. To examine the salivary peptidome from patients with a variety of oral disorders.

METHODS

The salivary pellicle proteins were identified using an in vitro hydroxyapatite (HA) model and HPLC-nanospray mass spectrometry. Antibodies against caseins were used to detect the interaction between the CPP and saliva. Mass spectrometry was used to investigate the salivary peptidome.

RESULTS

HA-binding salivary proteins included agglutinin, mucin, immunoglobulins, salivary enzymes, proline-rich proteins (PRP), cystatins and histatin 1. An ELISA was also developed that demonstrated both the anticariogenic peptides α_{S1}-CN(59-79) and ß-CN(1-25) bind to saliva, and ß-CN(1-25) showed a greater degree of binding. The mass spectrometry data as well as the information on the inorganic constituents and medical history of the subjects were stored in a specifically designed salivary database. The salivary peptidome, as detected by mass spectrometry revealed variation in the pattern of proteolytic fragments of proline-rich proteins between subjects with various oral disorders.

CONCLUSIONS

The anticariogenic activity of CPP may involve a specific interaction with salivary proteins forming the enamel pellicle. Mass spectrometry is a useful technique for the detection of the salivary proteins including PRP fragments and antimicrobial α-defensins in saliva (human neutrophil peptides 1, 2 and 3) that are currently being evaluated as potential biomarkers.

EFFECT OF CPP-ACP VERSUS POTASSIUM NITRATE ON CERVICAL DENTINAL HYPERSENSITIVITY

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The clinical problem of cervical dentinal hypersensitivity (CDH) can be managed by strategies that occlude patent dentin tubules exposed to the oral environment, or that reduce the excitability of pulpal nerves. Preliminary studies have shown that topical application of a CPP-ACP gel can cause blockage of dentin tubules.

OBJECTIVES

This randomized clinical trial compared the therapeutic effect of a 10% CPP-ACP gel (GC Tooth Mousse) with a well established KNO_3 dentifrice (Colgate Sensitive) over six weeks.

METHODS

Patients (n=18 per group) screened from a general practice setting presenting with CDH used either CPP-ACP gel applied topically each night before retiring in conjunction with their conventional dentifrice twice daily, or the KNO_3 dentifrice twice daily. CDH responses to four types of stimuli were self-rated using a visual-analogue scale after 4wk and 6wk of treatment, and a composite score calculated. Data were analyzed in a blinded manner.

RESULTS

The two groups were well matched with no significance difference in baseline scores. In both the CPP-ACP and KNO_3 groups, when compared with their relevant baseline values, CDH scores were reduced significantly at 4wk (on average by 46.9% and 46.8%, respectively) and at 6wk (by 56.8 and 64.4%, respectively), when assessed using a repeated measures ANOVA ($P<0.01$ at 4wk and $P<0.001$ at 6wk). In each group, only 2 of the 18 subjects did not show a response, and each of these had relatively low baseline scores. The further reduction in CDH scores which occurred from weeks 4-6 in both groups was not statistically significant. At each of the 4wk and 6wk time points, there were no significant differences between the two treatment groups.

CONCLUSIONS

Despite differences in their apparent mechanisms of action, both CPP-ACP gel and the KNO_3 dentifrice give similar useful reductions in self-rated symptoms of CDH.

EFFECT OF CPP-ACP ON HARDNESS OF ENAMEL ERODED BY COLA-DRINK

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OBJECTIVE

This in vitro study evaluated the remineralization effect of Casein Phosphopeptide- Amorphous Calcium Phosphate (CPP-ACP) from GC Tooth Mousse (GC Asia Dental, Japan) on hardness of enamel eroded by Cola-drink.

METHODS

Ten extracted human premolars were bucco-lingually cut into 2 halves and embedded in resin providing 20 specimens with buccal and lingual experimental sites. The specimens were polished (1 micron diamond slurry, Imptech, South Africa) and baseline Vickers hardness was measured (100g force, 15s) to demonstrate the effect of mineral changes. The demineralization process was done by immersion of specimens in Cola-drink (Thai Namthip Co. Ltd, Thailand) and artificial saliva (Chulalongkorn University, Thailand) (5s each for ten cycles) for three times with two immersions in artificial saliva for 6h among the 3 alternate immersions. All specimens were rinsed with deionized water and the hardness measurements were repeated. For remineralization process, the demineralized specimens were randomly divided into 4 groups (n=10) and 4 regimens of remineralization used CPP-ACP (group 1), artificial saliva (group 2), CPP-ACP and artificial saliva (group 3) and deionized water as control. After remineralization process, hardness measurements were repeated. Statistical analysis used Oneway ANOVA followed by Bonferroni test (alpha = 0.05).

RESULTS

The hardness of the specimens at baseline, after demineralization and after remineralization of group 1 (246.7±3.2, 209.1±13.6, 247.3±5.2), group 2 (245.2±6.4, 207.9±7.8, 228.1±9.2), group 3 (248.3±6.2, 205.6±6.5, 242.6±12.1) and control group (239.1±17.9, 207.0±8.2, 210.0±8.5) were demonstrated with standard deviation respectively in bracket. After remineralization, all groups showed significantly higher hardness value than control ($p<0.05$). The CPP-ACP and CPP-ACP with artificial saliva groups demonstrated significantly higher hardness value than the artificial saliva group ($p<0.05$).

CONCLUSION

CPP-ACP from GC Tooth Mousse can increase hardness of enamel eroded by Cola-drink. The remineralization effect of CPP-ACP is significantly higher than that of artificial saliva in vitro.

AN IN VITRO STUDY OF WEAR PREVENTION IN DENTINE

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Tooth wear is a significant problem facing clinicians, and several approaches are being used to manage it.

OBJECTIVE

This study aims to quantitatively and qualitatively test the efficacy of Tooth Mousse® in managing dentin wear under highly controlled conditions.

METHODS

Eight dentin specimens from the lingual halves of third molar teeth were worn against enamel antagonists under a load of 9.95kg in an electro-mechanical tooth wear machine with hydrochloric acid lubricant (HCl) (pH=3), and with regular Tooth Mousse® application. A further eight dentin specimens were worn with Tooth Mousse® as the sole lubricant. Dentin wear was quantified by measuring reduction in dentin volume using a Dr PICZA 3D Scanner (PIX-4) and a MATLAB software package (version 6, The Mathwork Inc, Natick MA, USA), and assessed qualitatively by examining epoxy resin replicas under a scanning electron microscope. These data were then compared using ANOVA with data from two control experiments conducted under a load of 9.95kg with deionised water and HCl (pH=3) as lubricants, but no Tooth Mousse® was applied.

RESULTS

Dentin specimens worn with Tooth Mousse® as the sole lubricant exhibited minimal wear, and had very smooth and shiny wear facets. Those worn with HCl (pH=3) with regular Tooth Mousse® application showed less wear than both the control groups. Their wear facets were not obviously different from facets of control specimens worn with HCl (pH=3), but were smoother than those of specimens worn with deionised water as the lubricant. The control group worn with HCl (pH=3) exhibited less wear than that worn with deionised water, and also displayed smoother facets.

CONCLUSIONS

This study has shown that Tooth Mousse® is capable of reducing dentin wear, and has also highlighted the importance of lubricants in reducing wear. Further research is required to clarify its clinical usefulness of Tooth Mousse® in this context.

ENAMEL WEAR PREVENTION UNDER CONDITIONS SIMULATING BRUXISM AND ACID REGURGITATION

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Tooth wear is a growing public health problem and there is a need to better understand its aetiology and management.

OBJECTIVE

Our aim was to investigate the effectiveness of frequent applications of Tooth Mousse (GC Corporation) in preventing enamel wear in vitro, under conditions simulating bruxism and acid regurgitation.

METHODS

Sixteen human third molar teeth were sectioned longitudinally in a mesio-distal direction, and enamel halves of the same teeth were worn against each other in a purpose-built electromechanical tooth wear machine under a load of 10.0kg with hydrochloric acid lubricant (pH = 1.2) for around 10,000 test cycles. In the experimental sample (n = 8), the machine was stopped every two minutes (160 cycles of wear) and the specimens washed and dried. MI Paste was then applied for four minutes. The specimens were further washed and dried before the cycle was continued. The same protocol was followed for the control specimens (n = 8) but no GC Tooth Mousse® was applied. Tooth wear was quantified by measuring reduction in enamel volume per 1,000 cycles using a Dr PICZA 3D Scanner (PIX-4) and MATLAB software package (version 6, The Mathwork Inc, Natick MA, USA). Wear rates were compared between the samples with an unpaired t-test. Qualitative assessment was also carried out using Scanning Electron Microscopy (SEM).

RESULTS

The rate of enamel wear was significantly lower in the experimental sample (0.41 mm^3 per 1,000 cycles) than in the control sample (1.01 mm^3 per 1,000 cycles) ($p<0.01$). Enamel wear facets in the experimental sample were also found to be smoother than those in the control sample.

CONCLUSIONS

Frequent application of GC Tooth Mousse® is effective in reducing enamel wear under conditions simulating bruxism and acid regurgitation, probably due to its lubrication properties. These findings open up new possibilities for the prevention of tooth wear.

CPP-ACP GUM SLOWS PROGRESSION AND ENHANCES REGRESSION OF DENTAL CARIES

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OBJECTIVES

To investigate the radiographic progression and regression of dental caries in adolescent subjects chewing a gum containing CPP-ACP over a two-year period.

METHODS

2720 subjects were randomly assigned to either a test or control group. All subjects received accepted preventive procedures, including fluoridated water, fluoridated dentifrice, and access to professional care. The test group received a sugar-free gum containing 54.4mg CPP-ACP while the control group received an identical gum without CPP-ACP. Subjects were instructed to chew their assigned gum for ten minutes 3x per day, with one session supervised on school days, over the 2-year study period. Standardised digital radiographs were taken at the baseline and at the completion of the clinical trial using the Dexis digital X-ray system. The radiographs, scored by a single examiner, were assessed for approximal surface dental caries at both the enamel and dentin level. Analysis of caries progression or regression was undertaken using a transition matrix.

RESULTS

There was a statistically significant difference in the distributions of the transition scores between the two groups (P value < 0.001). The CPP-ACP gum slowed progression of carious lesions compared with the control gum. For subjects chewing the CPP-ACP gum, 814 (4.41%) of approximal surfaces experienced caries progression compared to 932 (5.31%) approximal surfaces in the control group, a reduction of 16.9%. The CPP-ACP gum enhanced regression of carious lesions compared with the control gum. 56 (0.30%) of approximal surfaces experienced caries regression with the CPP-ACP gum compared to 36 (0.21%) approximal surfaces with the control gum. A greater percentage of approximal surfaces remained unchanged with the CPP-ACP gum than with the control gum.

CONCLUSION

A chewing gum containing 54.4mg CPP-ACP significantly slowed progression and enhanced regression of dental caries in a two-year clinical trial relative to a normal sugar-free gum.

IMPROVED PLAQUE UPTAKE AND ENAMEL REMINERALIZATION BY FLUORIDE WITH CPP-ACP

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Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) has been shown to slow the progression of caries and to remineralize enamel subsurface lesions.

OBJECTIVES

The aim of the studies was to determine the ability of CPP-ACP to increase the incorporation of fluoride into supragingival plaque and to promote enamel remineralization in situ with acid resistant mineral.

METHODS

Randomized, double-blind cross-over studies were designed involving three mouthrinses and five toothpastes as follows: Mouthrinses (i) 2% CPP-ACP, (ii) 2% CPP-ACP plus 450ppm F and (iii) 450ppm F; and Toothpastes: (i) placebo, (ii) 1100ppm F, (iii) 2800ppm F, (iv) 2% CPP-ACP and (v) 2% CPP-ACP plus 1100ppm F. The mouthrinses (15ml) were used for 60 sec, three times per day for 5 days and supragingival plaque collected and analyzed for F content. The toothpastes (1g) were added to 4ml water to form a slurry and used for 60 sec four times per day for 14 days in an in situ remineralization model.

RESULTS

The addition of 2% CPP-ACP to the 450ppm F rinse significantly increased the incorporation of fluoride ions into plaque where the plaque fluoride level (33.0±17.6nmol/mg dry wt) was over double that obtained with the fluoride-only rinse (14.4±6.7nmol/mg dry wt). Fluoride in the toothpaste slurry produced a dose-response related remineralization of subsurface enamel lesions. The toothpaste containing 2% CPP-ACP produced a level of remineralization (13.5%±1.5%) similar to the 2800ppm F paste (15.5%±2.4%) and the paste containing 2% CPP-ACP plus 1100ppm F was superior (21.0%±5.9%) to all other formulations in enamel lesion remineralization. Acid challenge of the remineralized lesions showed that the CPP-ACP/F mineralized lesions were relatively acid resistant.

CONCLUSION

CPP-ACP promotes the incorporation of fluoride into plaque and sub-surface enamel producing effects superior to fluoride alone.

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