

# Remineralization strategies

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Jul 1st, 2006



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During the past seven years there has been increased interest and development in calcium phosphate-based remineralization technology. Since these technologies are relatively new, the goal of this article is to increase the clinician's knowledge of the demineralization/remineralization process, the products available, and ideas for implementation into daily practice.

Remineralization and demineralization have a significant impact on the strength and hardness of dental enamel. Remineralization and demineralization are processes that occur on the tooth surface. Since there is no connection between the bloodstream and tooth enamel, mineral supplements have no impact on the remineralization process. The reverse is also true. Events that draw minerals out of the blood, such as pregnancy or a broken bone healing, do not extract minerals from the teeth.<sup>1,2</sup>

Demineralization is the process of removing mineral ions from dental enamel, essentially "dissolving the enamel." Dental enamel is a crystalline latticework made up of various minerals, primarily a complex calcium phosphate mineral called hydroxyapatite. A substantial number of mineral ions can be lost from the hydroxyapatite latticework without destroying its structural integrity. Although the integrity of the tooth is still intact, a patient may experience hot, cold, pressure or pain much more readily than before demineralization. A severely demineralized spot on a tooth that hasn't yet formed a cavity may have the symptoms of a cavity. In some cases, when too many minerals are dissolved from an area of the hydroxyapatite's latticework, a cavity results. Fortunately, the latticework can be strengthened and restored through the natural

process of remineralization by eating unprocessed foods rich in minerals, such as natural and organic foods.<sup>1,2</sup>

Remineralization is the process of restoring mineral ions to the tooth structure, and can be compared to replacing the missing links in a chain. The lost mineral ions must be replaced with ions of the same shape, size and electrical charge. Remineralization involves carbon dioxide from breath and water from saliva to create a mild, unstable carbonic acid that is at the core of the natural remineralization process. Minerals in saliva present from food are dissolved by the carbonic acids. In addition, carbonic acid quickly and easily converts to carbon dioxide and water. When this happens, the dissolved mineral ions precipitate out as solid mineral ions again, but not always as the original mineral molecules. If a particular mineral ion is near a demineralized portion of the hydroxyapatite crystal that requires that ion, the ion is incorporated into the dental enamel. Though natural remineralization is always taking place, the level of activity varies according to conditions in the mouth. In fact, for remineralization to proceed, six conditions or events must occur at the same time:

- Sufficient minerals must be present in the saliva. Food is the principal source of minerals for the teeth, therefore an adequate diet and sufficient time spent chewing (this transfers minerals to the saliva) is vital.
- A molecule of carbonic acid must be produced. A very small fraction of the carbon dioxide from the breath is converted to carbonic acid.
- The carbonic acid molecule must be produced in proximity to a mineral molecule, which then dissolves into its ionic components.
- This all has to occur in proximity to a demineralized spot in the hydroxyapatite latticework that requires the exact mineral ion.
- The demineralized spot has to be clean and accessible so the mineral ion is attracted to the “hole” in the lattice by the opposite electric charges of the ion and the “hole.” Many different ions have the correct charge, but only the correct ion has the correct shape and size to fit into the “hole.”
- The carbonic acid must convert to carbon dioxide and water before any of the above circumstances change. When this happens, a mineral ion is precipitated out of solution into the structure of the enamel.<sup>1,2</sup>

Since natural remineralization is frequently inadequate to maintain strong enamel, especially in today's world of processed foods and refined sugars, the natural remineralization process needs to be augmented. Remineralization must be enhanced, or demineralization must be retarded.<sup>1,2</sup>

There are currently three technologies that offer claims of remineralization:

- Recaldent, found in GC America's PROSPEC MI paste and Trident chewing gum
- Amorphous calcium phosphate (ACP) found in Arm & Hammer's Enamel Care Toothpaste, Discus Dental's Nite White bleaching gel and Premier Dental's Enamel Pro polishing paste
- SensiStat, found in Ortek Therapeutic's Proclude and Denclude products<sup>1,2,3</sup>

See the related boxes in this article for more information.

Also worth mentioning is a new technology called NovaMin, a synthetic mineral composed of calcium, sodium, phosphorus and silica, the driving mechanism that binds to the tooth surface. The sodium buffers the pH to allow for precipitation of crystals onto the tooth surface. There is a rapid and continuous release and deposition of a natural crystalline hydroxyl-carbonate apatite (HCA) layer that is chemically and structurally the same as tooth mineral. SootheRx by OMMII and Sunstar Butler's NuCare prophylaxis paste both contain NovaMin.<sup>7</sup>

## Patient care strategies

One of my colleagues who works with the JP Institute told me that as a trial, she placed two of her patients on SootheRx. Both of these patients suffered from such severe sensitivity that they could not tolerate a continuing care visit. The protocol for SootheRx is use twice a day for two weeks followed by once a week for six months. After only two weeks, the patients returned for continuing care with complete relief. By using SootheRx once a week, the patients continue to be sensitivity free.

There are several ways to treat a caries infection, most of which involve combined home use of chlorhexidine and fluoride. With remineralization therapy, areas in the patient's mouth that are demineralized and run the risk of cavitation have a good chance of remineralizing before cavitation occurs. Of course, anything that can be done to assist the patient in reversing the demineralization process is of significant value.

Since demineralization occurs when the tooth undergoes an acid challenge, the first step is to reduce the frequency of that challenge. Nutrition and diet are a chief concern, especially today

where we encounter more processed than fresh food. Telling patients of the importance of fresh fruits and vegetables, which provide the minerals our bodies need to naturally remineralize the tooth structure, should be part of the recall or continuing care hygiene protocol.

For those who have active decay or areas of demineralization (white spots), daily use of a chewing gum with ACP is highly recommended, in addition to a healthy diet. Trident Advantage, Trident for Kids, and Trident Whitening all contain appropriate amounts of ACP. Two sticks of gum should be chewed for five minutes, five times per day to assist in the remineralization process and maintenance of healthy saliva flow.<sup>6</sup> My current patient recommendation is to chew the ACP gum for five minutes after breakfast, after lunch, mid-day, after dinner and before bed. This accomplishes the suggested “five for five” per day regimen to remineralize the affected areas.

Patients may use MI paste at home. They simply brush, floss, then rub the MI paste on the demineralized areas with their fingers. No rinsing is needed. MI paste is also well utilized during a hygiene visit when applied with the rubber cup in the same way as polishing, without rinsing afterward.<sup>3,4</sup> For ongoing home use, the clinician should recommend Enamel Care Toothpaste with ACP by Arm & Hammer. Replacing daily use of regular toothpaste with ACP makes the calcium and phosphate readily available for use in the saliva. Keep in mind the need for fluoride use if toothpaste with fluoride is omitted.<sup>8</sup>

For in-office use, a polishing paste containing one of the remineralization technologies should be used with each periodontal maintenance or continuing care appointment. Either Enamel Pro or Proclude will meet the in-office requirements.

The greater our ability to arrest disease and the more we take advantage of remineralization technologies, the better our patients are served. Clinicians should research these products and their application for home use by the patient, as well as professional use. Your patients will be glad you did.

## References

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a bicarbonate dentrifice containing calcium and phosphate.” Abstract 2115

6. ACP is patented technology exclusively licensed to Discus Dental, Inc. in the field of whitening by the ADA Foundation, Paffenbarger Research Center.

7. Ortek Web site - [www.ortek.com](http://www.ortek.com)

8. Remineralization Potential of a New Toothpaste Formulation: An In-Vitro Study, The Journal of Contemporary Dental Practice, Vol. 5, No.1, Feb. 15, 2004

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**Recaldent** was discovered and patented by members of the School of Dental Science at the University of Melbourne in Australia. It is derived from casein, part of the protein found in cows milk. It is technically called casein phosphopeptides-amorphous calcium phosphate, or CPP-ACP.<sup>3</sup>

Recaldent acts in unique ways to deliver calcium and phosphate to the tooth enamel and promote remineralization in the following ways:

- The peptide part of Recladent, the casein phosphopeptides or CPP, maintains calcium and phosphate in an amorphous soluble form.
- The CPP bind to the surface of the tooth and the bacteria in plaque surrounding the tooth, presenting this soluble calcium phosphate at a high concentration at the tooth surface.
- In its amorphous, soluble form, the calcium and phosphate can penetrate into the tooth enamel and remineralize it.<sup>3</sup>

MI Paste is applied to teeth at home with a finger or in a custom tray. A hygienist can also apply it professionally with a polishing cup during a cleaning visit. For maximum benefit, leave the paste on the teeth for three to five minutes, then expectorate and do not rinse with water.<sup>3</sup>

Research shows that CPP-ACP binds well to plaque and provides a large calcium phosphate reservoir within plaque that will likely restrict mineral loss during a cariogenic episode, and provide a source of calcium for subsequent remineralization. Once in place, CPP-ACP will restrict the caries process. The addition of CPP-ACP to either sorbitol- or xylitol-based sugar-free chewing gum results in an increase in enamel remineralization. This indicates the use of Trident could reduce the incidence of tooth decay.<sup>4</sup>

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**ACP** Dr. Ming S. Tung developed ACP technology at the American Dental Research Association’s Paffenbarger Research Center. In 1999, ACP was incorporated into a toothpaste called Enamelon, which failed in the marketplace. It was reintroduced in 2004 in Enamel Care Toothpaste by Church and Dwight (Arm & Hammer).<sup>4</sup>

ACP requires a two-phase delivery system to keep the calcium and phosphorous from reacting with each other before use. This is done through a dual compartment tube in the Enamel Care toothpaste. The calcium and phosphorous sources are two salts, calcium sulfate and dipotassium phosphate. When these are mixed together, they rapidly form ACP that can precipitate onto the tooth surface, dissolve into the saliva and be subsequently available for tooth remineralization.<sup>5</sup>

Nite White bleaching gel combines a carbamide peroxide formula with ACP that claims to rebuild enamel while whitening. ACP is also available in Enamel Pro polishing paste, which increases the delivery of fluoride (31 percent) into the enamel.<sup>6</sup>

In addition, dental professionals take advantage of ACP technology when using any of the products in the Aegis line produced by Bosworth, including the company's Aegis pit and fissure sealant.

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**SensiStat** Dr. Israel Kleinberg developed SensiStat at the Department of Oral Biology and Pathology at State University of New York at Stony Brook. This technology is made of arginine bicarbonate, an amino acid complex, and particles of calcium carbonate, a common abrasive in toothpaste. SensiStat was first marketed in 2003 in Ortek's Proclude desensitizing prophylaxis paste, and later in Denclude, a professionally dispensed sensitivity paste for home use launched in 2004.<sup>5,7</sup>

SensiStat is made of arginine bicarbonate, amino acid complex and particles of calcium carbonate, commonly used in toothpaste as an abrasive. The arginine complex is responsible for adhering the calcium carbonate particles to the dentin or enamel surface. However, the research and literature on SensiStat indicate the calcium carbonate has "poor solubility." Calcium carbonate is not very soluble and releases very low levels of calcium into the oral cavity. SensiStat does not increase calcium levels in saliva as significantly as the other calcium phosphate technologies do to enhance remineralization. Proclude prophylaxis paste and Denclude take-home product are more effective for desensitization than for remineralization.<sup>5,7</sup>