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Evaluation of novel mouthwash on dental remineralization

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Abstract
The microorganisms are responsible for the generation of the acids which lead to the demineralization and weakening of the enamel. Hence based on these findings the present study was planned to demonstrate the effect of the mouthwash on Dental remineralization.
The data from the 3 study group were collected and presented as below. The enamel were administered with the Sensodyne Pronamel Daily Mouthwash, listerine Advanced Defence Cavity Guard and no Mouthwash. The chips were subjected to 6 hours of demineralization. At the end of each application, samples were detached from the retainer for micro hardness measurements consisting individual micro hardness indentation measurements in Knoop units.
From the data generated in the above mouthwash application on the enamel it is concluded that the applied mouthwash achieves the comparable remineralisation. This will helpful in the selection of mouthwash for the different enamels. The studies above are the initial evidence to encourage further exploration into the philosophy of multiple mechanisms acting together for caries prevention.

Keywords: mouthwash, remineralization, sensodyne

Introduction
Tooth remineralisation is a naturally occurring process in the oral cavity. It is defined as a process in which calcium and phosphate ions are sourced to promote ion deposition into crystal voids in demineralised enamel. Remineralisation remains imperative towards the management of non-cavitated carious lesions and prevention of disease progression within the oral cavity. The process also has the ability to contribute towards restoring strength and function within tooth structure.
Tooth demineralization is a chemical process by which minerals (mainly calcium) are removed from any of the hard tissues: enamel, dentine, and cementum. The process of demineralization begins at the crystal surface found inside the hard tooth tissue and may progress into cavitation unless arrested or overridden by remineralisation. The effect of demineralisation can be reversed if there is sufficient time to allow remineralisation to occur to counteract the acids in the oral cavity. Together, demineralisation and remineralisation contribute towards a dynamic process [1].
Dental caries is a multifactorial disease caused by the interaction of dietary sugars, dental biofilm and the host's dental tissue within the oral environment. It is the cumulative result of consecutive cycles of demineralization and remineralization at the interface between the biofilm and the tooth surface. Oral bacteria excrete acid after consuming sugar, leading to demineralization. Upon this acid challenge, the hydroxyapatite crystals are dissolved from the subsurface. Remineralization is the natural repair process for non-cavitated lesions. It relies on calcium and phosphate ions, assisted by fluoride, to rebuild a new surface on the existing crystal remnants in the subsurface. The remineralized crystals are less acid soluble than the original ones.
Under normal physiological conditions (pH7), saliva is supersaturated with calcium and phosphate ions, making caries progress slow. However, as the bacteria in the biofilm continue to produce acid with sugar consumption, plaque pH falls to 4.5-5.5. This shifts the driving force within the tooth to mineral dissolution. As the pH is lowered, the saturation point of the minerals in the surrounding fluid is changed. The lower the pH, the higher the concentrations of calcium and phosphate required to reach saturation with respect to hydroxyapatite. This is called the "critical pH", the point where equilibrium exists. There is no mineral dissolution and no mineral precipitation. The critical pH of hydroxyapatite is around 5.5 and that of Fluor apatite is around 4.5. This varies with individual patients. Below critical pH, demineralization occurs while above critical pH, remineralization occurs.
The critical pH is significantly higher for children than adults. Children have a greater driving force for demineralization in a more acidic oral environment and a decreased driving force for remineralization at normal oral pH. This puts children at greater risk for demineralization than adults.
It has been known since the 1980s that fluoride controls caries predominantly through its topical, not systemic, effect. Four mechanisms are involved [2].

1) Fluoride inhibits demineralization
If fluoride is present in the plaque fluid when bacteria produce acids, it will penetrate along with the acids at the subsurface, adsorb to the apatite crystal surface and protect the crystals

from dissolution. This coating makes the crystals similar to Fluor apatite (critical pH of 4.5) ensuring that no demineralization takes place until the pH reaches this point. Fluoride present in solution at low levels among the enamel crystals can markedly inhibit dissolution of the tooth mineral by acid. This fluoride comes from topical sources such as drinking water, and fluoride products like toothpastes and varnishes. The fluoride, which is incorporated systemically into the tooth, is insufficient to have a measurable effect on its acid solubility.

2) Fluoride enhances remineralization

When the pH returns to pH 5.5 or above, the saliva which is supersaturated with calcium and phosphate, forces mineral back into the tooth.7 Fluoride adsorbs to the surface of the partially demineralized crystals and attracts calcium ions. This new surface veneer takes up fluoride preferentially from the solution around the crystals and excludes carbonate [3].

Fluoride speeds up the growth of the new surface by bringing calcium and phosphate ions together and is also preferentially incorporated into the remineralized surface. This produces a surface which is now more acid resistant.

3) Fluoride may inhibit essential bacterial activity

Fluoride cannot cross the bacterial cell wall in its ionized form (F). However in an acid environment, F combines with H to form HF which easily diffuses into the bacterial cell. Inside the cell HF breaks up and releases fluoride ions that interfere with the essential enzyme activity of the bacterium [4].

4) Fluoride is retained in intraoral reservoirs after the application of a fluoride treatment such as toothpaste, varnish or restorative material and is then released into the saliva over time [5]

Fluoride can remain on dental hard tissue, the oral mucosa or within the dental plaque. Fluoride retention, especially in dental plaque, is clinically beneficial since it can be released during cariogenic challenges to decrease demineralization and enhance remineralization. The potential benefit of using fluoride in combination with antimicrobial agents such as chlorhexidine, triclosan, or essential oils is the reduction of cariogenic microorganisms and consequently plaque acidogenicity. These microorganisms are responsible for the generation of the acids which lead to the demineralization and weakening of the enamel. Hence based on these findings the present study was planned to demonstrate the effect of the mouthwash on Dental remineralization.

Methodology

The present study was planned in the Department of Dentistry in Sri Krishna Medical College and Hospital. Total 90 enamel were evaluated in the present study. The enamel were administered with the Sensodyne Pronamel Daily Mouthwash, LISTERINE Advanced Defence Cavity Guard and no Mouthwash. During study, subjects brushed their teeth for2 minutes twice daily and abstained from all oral hygiene measures other than the prescribed protocol. The mouthwashes were all dispensed in the same generic no transparent containers. Mouthwash use proceeded as follows: with the retainer in place the subject rinsed with the standard, recommended amount of mouthwash around the palatal area of the appliance where the chips were mounted for 60seconds. The chips were subjected to 6 hours of demineralization using an acetate/calcium/ phosphate buffer at pH 4.4.The buffer contained: 2.0 mmol/l calcium, 2.0 mmol/l phosphate and75 mmol/l acetate, with 40 ml per sample used individually [6]

The demineralized chips were then attached to the palatal surface ofeach retainer with approximately 0.75 to 1.5 cm separation between them and left in place over the duration of that arm of the study (5days). At the end of each application, samples were detached from the retainer for micro hardness measurements consisting individual micro hardness indentation measurements in Knoop units.

Results & Discussion

The data from the 3 study group were collected and presented as below. The enamel were administered with the Sensodyne Pronamel Daily Mouthwash, LISTERINE Advanced Defence Cavity Guard and no Mouthwash.

Table 1: Comparison of mouthwash and control microhardness ratio

Type of Mouthwash	Micro hardness
Sensodyne Pronamel Daily Mouthwash	1.12 – 1.29
Listerine Advanced Defence Cavity Guard	1.04 – 1.14
No mouthwash	0.95 – 1.05

The antiquaries benefits of fluoride have been proven extensively for a variety of oral care treatments from toothpastes, mouth rinses, and varnishes, to gels [7]. However, the systematic review of the use of sodium fluoride mouth rinses in controlled clinical trials by Twetman *et al*. concluded that there was limited evidence that daily or weekly rinsing with fluoride mouth rinse had a significant caries-reducing effect on young permanent teeth compared with placebo [8]. In another review, Marinho *et al*. evaluated five different trials involving fluoride toothpaste plus fluoride mouth rinse versus toothpaste alone (n = 2738) [8]. While not in contrast withTwetman *et al*.'s conclusions, the results of Marinho' srandom effects-meta-analysis of the five trials found that the trials have a combined prevented fraction pooled estimate of 0.07(95% CI, 0.00 to 0.13; P = 0.06). This result was directionally in favour of the combined regimen (fluoride toothpaste plus fluoride mouth rinse) within a relatively narrow confidence interval for pooled estimate of effect. One would predict that an upgrade in mouth rinse formulation would further enhance treatment effect.

Ten Cate and Duijisters *et al*., in 1982 and Featherstone *et al* in 1986 described pH cycling model, which are most commonly used. Two modified models for re/demineralizing experiments on primary teeth have emerged. A 7-day pH cycling experiment and a 10-day pH cycling with 0.25 ppm fluoride added to the remineralizing and demineralizing solutions. Thaveesangpanich *et al*. conducted a pH cycling experiment on primary teeth, without fluoride in the remineralizing or demineralizing solutions and found that all of the sections were eroded by the 8th day of the experiment and hence rendered the sections inappropriate for evaluation. [9] As the addition of fluoride to the demineralizing solution have an inhibitory effect on the rate of demineralization it will interfere with the re/demineralization carried out in study and

alter the results. In this study, 7 days' pH cycling is used instead of 10 days' pH cycling. However, this shortening of the period of the pH cycling might produce results that inadequately represent the natural process of re/demineralization.

There have been very few studies on the efficacy of fluoride dentifrices on primary teeth especially using single section pH cycling models. The basic components of the single-section model were described by Wefel *et al*. in 1987 [10] The single-section model used in this study has the advantage that the same tissue can be measured before and after the experiment; thus any changes due to exposure to the treatment regimen can be evaluated.

Conclusion

From the data generated in the above mouthwash application on the enamel it is concluded that the applied mouthwash achieves the comparable remineralisation. This will helpful in the selection of mouthwash for the different enamels. The studies above are the initial evidence to encourage further exploration into the philosophy of multiple mechanisms acting together for caries prevention.

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