Remineralization and Anti-Caries Potential of a nano-Hydroxyapatite Post-Brushing Dental Lotion

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Objective

The aim of this randomized, double-blind, two-arm crossover in situ study was to investigate whether nano-hydroxyapatite (nano-HAP) dental lotion applied immediately after tooth-brushing with nano-HAP toothpaste enhances the remineralization and caries prevention efficacy of nano-HAP toothpastes.

Introduction

- The natural caries protective and remineralizing effects of saliva is not only a slow process but obviously insufficient to protect individuals against caries and remineralize existing lesions without additional agents to enhance its effects.
- The presence of additional extrinsic sources of stabilized Ca^{2+} and PO_4^{3-} ions could augment the natural caries control potential of saliva by increasing diffusion gradients favoring faster and deeper subsurface remineralization.[1]
- The potential of nano-hydroxyapatite to inhibit tooth demineralization and promote remineralization of the initial caries lesion is now well established with supporting evidences.[2]
- Nanoparticulate hydroxyapatite may act as a calcium and phosphate reservoir, helping to maintain a topical state of supersaturation of these ions with respect to enamel minerals.[3]
- Deposition on the surface of the demineralized enamel might promote remineralization of the enamel caries lesion.[3]
- Use of a nanoHAP-containing toothpaste elevated calcium concentrations in saliva, and caused the remineralization of early caries lesions in an in situ study.[4,5]
- We envisaged that completing toothbrushing with nano-HAP dental lotion would increase the bioavailable Ca^{2+} and PO_4^{3-} ions in saliva, on teeth surfaces and oral environment, thus enhancing the known caries control potential of nano-HAP toothpaste.
- The present study, therefore, evaluated the additional benefit, with respect to caries prevention and remineralization, of a nano-HAP dental lotion used immediately after toothbrushing with nano-HAP toothpaste.

Materials and Methods

This is a double-blind, randomized, crossover, single center, controlled *in situ* study.

The primary outcomes to be examined were (1) the percentage remineralization and lesion depth reduction measured relative to the baseline mineral loss and lesion depth for initial caries, and (2) the amount of mineral loss and lesion depth for the sound enamel.

UT Health San Antonio IRB approval was obtained (protocol#: HSC20180416H).

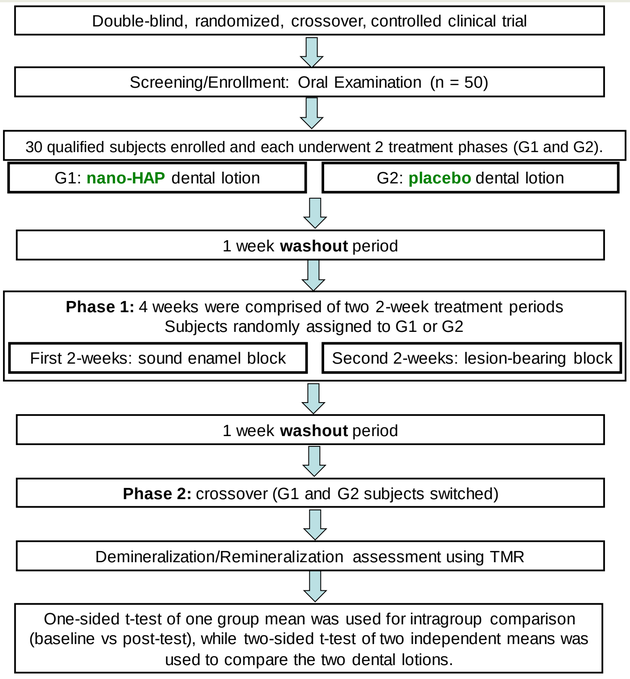
30 subjects, 18-60 years old with normal saliva flow rate, were recruited and they went through the study as shown in the chart below

- 30 Human permanent molar teeth were used to prepare 60 sound enamel blocks and 60 blocks bearing an artificially-produced initial caries lesion.
- 4 tooth blocks from each tooth, each mounted in an in situ appliance (Figure 2); 2 lesion-bearing blocks for remineralization enhancement assessment and 2 sound blocks for demineralization inhibition assessment.
- Mineral loss (Δz; vol%.µm) and lesion depth (ld; µm) of the artificial lesions were measured before and after intra-oral exposure with Transverse microradiography (TMR).

Figure 2: San Antonio in situ model

- Treatment groups:
  - **G1** (experimental arm): nano-HAP toothpaste + **5% nano-HAP containing dental lotion.**
  - **G2** (control comparator arm): nano-HAP toothpaste + **placebo dental lotion.**
- Each subject underwent 2 study phases. In each phase, subjects brushed 2x daily for 14 days using Nano-HAP toothpaste for 2 minutes, while wearing 2 appliances (1 sound and 1 lesion-bearing enamel). However, after bedtime brushing, subjects finished up with either nano-HAP or placebo dental lotion as described below.
- After bedtime (night) brushing, following rinsing with water, subjects poured one full portion of the dental lotion into their mouth, swished it around like a dental rinse, and used the toothbrush to gently spread it all over their teeth, including the appliance. The lotion was left in place for 2 minutes, and thereafter rinsed lightly with 10 ml of water. Subjects did not eat or drink for at least 30 min after using dental lotion.
- Safety was monitored at all visits by examination of the oral cavity and peri-oral area, and subjects were screened for adverse events using a questionnaire

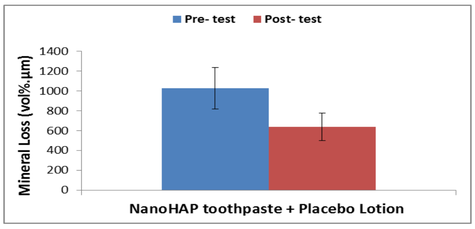
1. The mean amount of remineralization was determined for each group by intra-product comparison (pretest vs post-test) by t-tests.
2. The means of the lotion group and the placebo group were determined using the two-sided t-test of two independent means.



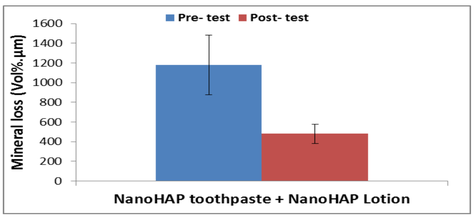
Results

TMR examination showed no demineralization in sound enamel blocks exposed to either of the dental lotions.

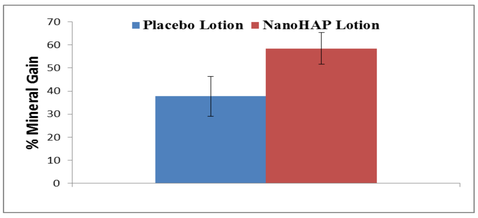
There were no incidences of adverse effects reported by subjects or ascertained clinically.



Pairwise comparison (baseline vs. post-test) indicated significant ($p<0.0001$) remineralization by the nano-HAP toothpaste in both the nano-HAP and the placebo lotion groups



When compared against each other, there was a significantly ($p<0.0001$) greater percentage of remineralization with post-brushing application of nano-HAP lotion (58.42 ± 1.76) than when placebo lotion was applied (37.72 ± 2.22).



Conclusions

Within the limitations of this study, it can be concluded that:

- ***The application of 5% nano-HAP containing dental lotion following toothbrushing with 5% nano-HAP toothpaste enhances the efficacy of nano-HAP toothpaste in remineralizing initial caries lesions.***
- ***Since the remineralizing efficacy of saliva is strictly dependent on the availability of calcium and phosphate ions, nano-HAP dental lotion may be a more effective for xerostomic patients with diminished amounts of saliva.***

References

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