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Comparative Evaluation of Remineralizing Agents on Early Enamel Lesions in Older Adults

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Abstract

This research evaluated and contrasted the efficacy of three distinct remineralizing treatments (Tricalcium phosphate (TCP) paste, Fluoride coating, and Nano-hydroxyapatite gel) with the instrument. The current clinical investigation was conducted on the first 90 carious lesions identified using caries diagnosis guidelines, followed by a baseline recording with the instrument. The chosen initial severe lesions were randomized and categorized into three categories based on treatment methods, with 30 lesions in each category, with the following remineralizing drivers: category A, group B (fluoride varnishes), and category C (nano-hydroxyapatite gels). The remineralizing chemicals were administered for four minutes biweekly for four weeks. During five weeks, the DIAGNO-dent ratings of primary carious lesions were documented to assess the impact of restoring medications. A paired t-test was employed to compare foundation data and follow-up ratings. A one-way Analysis of Variance (ANOVA) was performed to analyze results between all three categories. Post-Hoc Tukey testing was conducted to assess the substantial distinction among every category. Significant variations were seen between the three categories at follow-up ($p = 0.001$). Within every category, there was an essential difference between baseline and final follow-up grades ($p = 0.000$ for the three categories). Comparative analyses between each pair of groupings revealed a substantial difference in follow-up records among nano-hydroxyapatite and varnish with fluoride concerning pit and fissure cavities, with nano-hydroxyapatite demonstrating superior efficacy.

Keywords: Remineralizing Agents, Enamel Lesions, Older Adults, Review.

1 INTRODUCTION

The prevailing approach in caries management is the early identification and focused noninvasive treatment of irreversible invasive lesions with innovative remineralization agents Abdelaziz (2023). The biological demineralization of teeth occurs due to acidic assault from two primary sources: nutritional acids ingested via food or beverages and microbiological aggression from oral bacteria. Following an acidic assault or a standard demineralization process, the chemical dissolving of both inorganic and biological matrix constituents occurs Franceschelli et al. (2023). This phenomenon is

caused by the water content in enamel and dentine, which enables acid absorption into the teeth and the leaching of minerals out. The first step of demineralization is irreversible; hence, the partly demineralized hydroxyapatite (HA) stones in teeth regenerate to their former size when subjected to oral conditions conducive to remineralization Grawish et al. (2022). Dental decay is halted or remedied by improving the mineralization of teeth in the first stages.

The elevated levels of phosphates and calcium in saliva are the primary mineral supply in the oral cavity. The role of the phosphates, calcium, and hydroxyl ions in saliva is essential for apatite production Kučera et al. (2024). Remineralization commences when the sublingual pH is above the crucial threshold. This binds potassium and phosphorus inside the enamel, facilitated by sweat, fluorides, or other factors, producing reconstructed crystalline forms of fluoride hydroxyapatite and fluorescence.

The essential function of fluorine in regeneration is well-established and shown to be a practical approach. Recent scientific advancements have led to the introduction of novel fluoride and non-fluoride compounds on the marketplaces as revitalizing substances, including SDF, CPP-ACP, and CSP Haider et al. (2021). To assist academics and physicians in properly selecting and implementing different technologies, novel substances need verification and contrast with existing approaches. This research evaluates the efficacy of three contemporary remineralizing drivers.

2 BACKGROUND

2.1. Ethical Authorization and Study Structure

This research was an in vivo medical experiment done in the dental clinics of the Dental Teaching Medical Center, after obtaining ethical permission from the organizational ethics council. The experiment had three patient categories with initial severe lesions, designated accordingly to the restoring agent utilized.

2.2. Sample Quantity

This research specifically targeted the earliest carious lesions Jones et al. (2022). The population size was determined at a 91% confidence level, with a 9% confidence interval and an anticipated preventative caries rate of 75%. The first sample was valued at 85 and grew to 95 lesions.

2.3. Criteria for Participation

- individuals between the ages of 20 and 40, devoid of systemic conditions such as Sjogren's, mumps, obesity, and acidosis.
- Individuals exhibiting adequate oral hygiene (light to substantial plaque buildup).
- Individuals exhibiting non-cavitated first cavities are classified as grading 1 or 2 according to the International Caries Identification and Appraisal Systems (ICDAS) diagnostic standards for caries.

- The patient has not used remineralizing agents other than standard toothpaste in the last three weeks.

2.4. Criteria for Respondent Removal

Individuals with ionized glass restorations experience fluoride leakage in the tooth cavity, influencing the outcomes.

2.5. Randomization

The chosen initial severe lesions were arbitrarily categorized into three categories based on treatment approaches as follows:

- Class A (TCP cohort).
- Class B (Fluoride varnish cohort).
- Class C (Nano Hydroxyapatite cohort).

Each subject got a singular therapy method. Each substance was used to address 30 first carious lesions. Ninety cards, with thirty representing each therapy modality, were prepared, and the participant was thereafter instructed to randomly choose a card from an assortment beneath the researcher's watch.

2.6. Concealment

Unaware of the research concept and resources, a proficient and calibrated inspector conducted grading at the start and throughout several follow-ups Seet et al. (2022). An external statistician evaluated the gathered data.

2.7. Validity of Data

The consistency of measures was validated at baseline and throughout several follow-ups Jiang et al. (2023). The intra-examiner reliability of measures was validated before and throughout the investigation by education and calibration of the same evaluators. The measurement accuracy was evaluated using the Kappa test, resulting in an intra-examiner reliability of 88%.

The testing of in compliance with manufacturer specifications:

- "Activate the menu button (The calibrating symbol is shown).
- Activate the save button (calibrating starts).
- Upon hearing the signal, position the instrument horizontally on the baseline calibrating disk.
- The signaling tone ceases, indicating the conclusion of the calibrating process.

3 RESEARCH METHODOLOGY

Following acquiring ethical permission from the institutional regulatory commission under the designated procedure, 75 human mandible premolars removed for orthodontics or periodontist purposes were selected for this investigation. The inclusion criterion for tooth samples was noncarious,

undamaged crowns and teeth devoid of restorations. Upon verifying the criteria for inclusion using Radio Visio Graphy, specimens were examined under an operating microscope (10x) to rule out the potential for cracks, breaks, and morphological developmental defects. Tooth that had root canal treatment were eliminated. The tooth was sterilized using autoclaving at 120°C and 18 psi, thereafter, stored in newly made saliva substitutes until needed.

3.1 Processing of Specimens

The caps were detached from the roots employing a polished disk at a slow pace with a handpiece with an abundant water supply, and every crown was bisected in the mesiodistal orientation to access the lingual regions of the premolars. Teeth specimens were implanted in an acrylic material with the surfaces of the tongue oriented upwards, and dentin was removed using silicon dioxide abrasion sheets of grit sizes 1200, 500, and 300 sequentially to achieve surface flatness. Additionally, a 3 × 3 wax sheet was applied to the labial or sublingual regions to create an opening, and acid-resistant nail polish was applied to the remaining enamel. Specimens have been distributed into four categories of fifteen specimens each, based on the restoring agent utilized after each removing cycle, as shown below:

- Group 1: No remineralization reagent was administered (control group).
- Class 2: The specimen was coated with amorphous calcite phosphate fluorine (ACPF) paste for 3 minutes.
- Class 3: Biomin F powder was administered and allowed to remain for 3 minutes.
- Class 4: SAP P11-4 was administered for 2 minutes, and surplus material was eliminated without rinsing.

Ten specimens from each category, with a numerical designation in a single-blinded manner, were designated for surface microhardness assessment, two specimens from all groups for SEM examination, and three specimens from every category for research.

3.2 Assessment of Initial Material Microhardness and Measurements

Ten specimens from every group designated for enameled microhardness were evaluated using a Vickers hardness meter fitted with a diamond-shaped indentation. A uniform load of 250 g was exerted on the substrate for 10s. Five samples underwent examination to assess the Ca/P ratio of intact enamel, which was recorded as the starting point.

3.3 Demineralization-Remineralization Cycling

This cycle included whitening by soaking each of the 69 specimens in 35 ml of unstirred coca beverage (pH 2.8) for 5 minutes, then storage in synthesized saliva (pH 7.1) for 5 hours. Following 5 hours of preservation in fake sweat, pea-sized remineralizing chemicals from Groups 2, 3, and 4 were administered to enamel specimens according to the manufacturer's guidelines, requiring an additional 6 hours of preservation in synthetic saliva. This cycle was carried out bi-daily. Two calcification and

two regeneration processes were conducted daily, with intermediate preservation in synthetic saliva. After each calcification, the untreated group specimens were submerged in synthetic saliva until the subsequent demineralization. The procedure was performed for five days.

3.4 Post- Intervention Assessment

After five days, forty specimens (10 from each renewing cohort) that had been earlier evaluated for baseline surface microhardness were analyzed using a Vickers toughness tester with a diamond-shaped indentation, using the same methodology as the previous microhardness assessment. Variations in enamel toughness were documented. Eight specimens (two from each restoring subgroup) were subjected to sonication for 10 minutes, washed with ionized water, air-dried, coated with gold by sputtering, and analyzed to assess the structural characteristics of the enameled sample surfaces. For the remaining twenty specimens (five from every restoring group), modifications to mineral makeup were evaluated by computing the weight percentages of the two elements. Therefore, the Ca/P ratio was determined using an energy-dispersive X-ray spectrometer. The assessors were unaware of the sample groupings.

3.5 Quantitative Analysis

The results were examined with IBM SPSS. A paired t-test was used to compare baseline roughness with post-intervention roughness. The interpersonal evaluation of % variation in roughness was performed utilizing a post hoc Tukey's analysis ($p < 0.05$). A one-way estimation of variance examination was performed to compare the within-group results. The intergroup study of the Ca/P ratio was conducted using a post-hoc Tukey's examination, with a threshold for significance of less than 0.005.

4 RESULTS

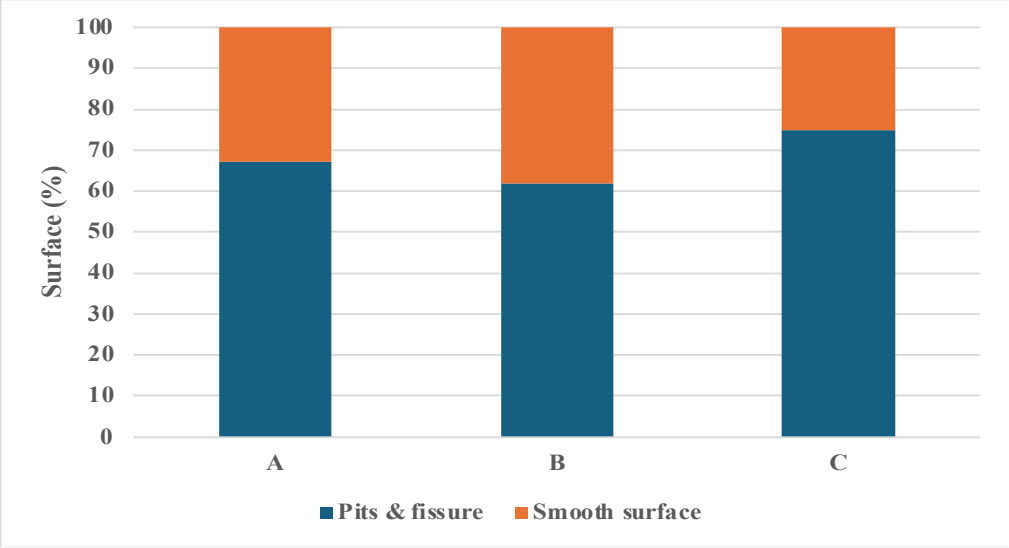

Figure 1: Surface Characteristics Analysis

No significant statistical differences were seen among the three subgroups for the quantities of pits, fissures, and smooth-surfaced early severe lesions ($p = 0.84$) (Fig. 1). A study of the effects of various remineralizing drugs indicated no significant variations between all three categories in the initial ratings ($P = 0.34$). Essential variations were seen between the two at follow-up ($p = 0.002$) [One-way ANOVA testing]. Significant variations were seen among initial and follow-up ratings within every category ($p = 0.001$ for all three categories) [combined t testing]. Fig. 2 highlights these variances.

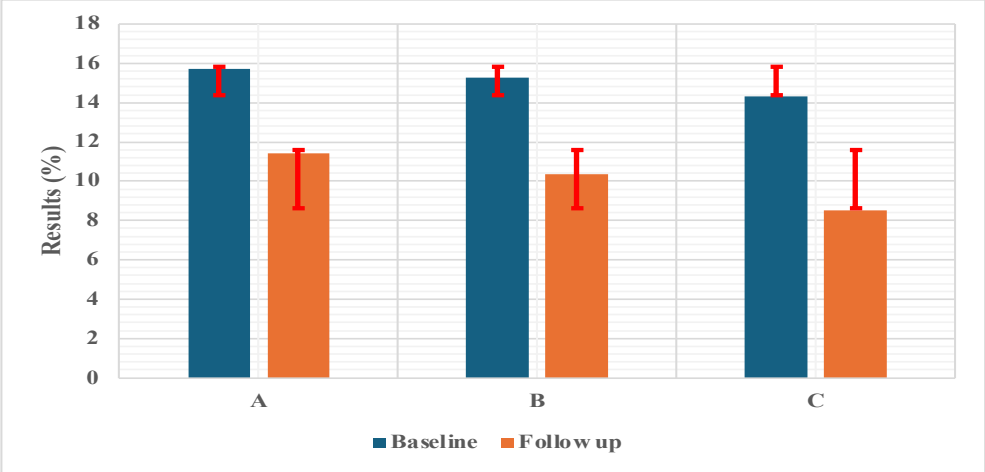

Figure 2: Baseline and Follow-up Analysis

A study of the impact of remineralizing chemicals on various tooth surfaces revealed no significant variations between all three categories for the DIAG-NOdent initial ratings for pits and fissures ($p = 0.054$) and smoothness ($p = 0.61$). Conversely, significantly noteworthy variations were identified in pits and fissure ratings ($p = 0.005$) during follow-up, but no significant variations were seen for flat surfaces ($p = 0.06$). A difference of statistical significance was seen between beginning and follow-up ratings within every category ($p = 0.001$ for all analyses) using a paired t-test. No substantial variations were seen at the beginning in the numerous contrasts across each pair of groups. A significant difference was seen at follow-up among nano-hydroxyapatite and TCP, in addition to varnish with fluoride, regarding pit and fissure cavities ($p = 0.041$ and $p = 0.008$), along with an overall impact ($p = 0.005$ and $p = 0.003$). No significant variation was seen between TCP and fluoride varnishes for fissure cavities—no crucial modifications in the smooth-surfaced follow-up, as shown in Fig. 3.

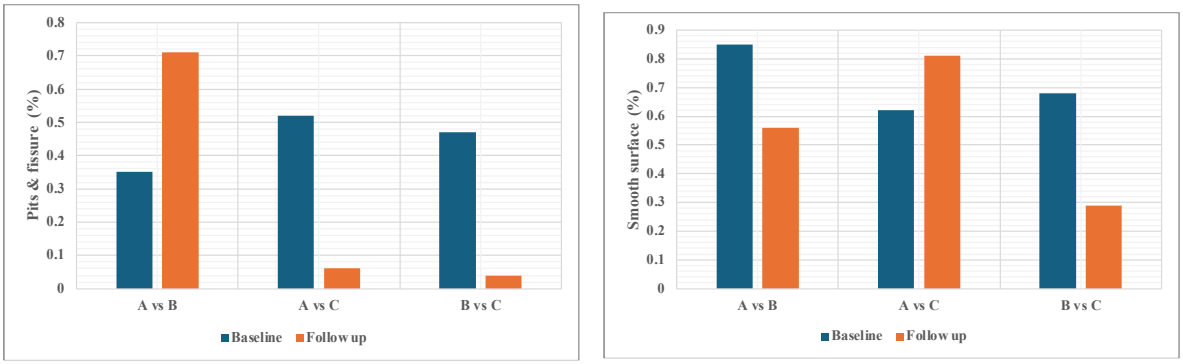

Figure 3: Pits & Fissures and Smooth Surface Analysis

5 CONCLUSION

The current investigation determined that the three remineralizing compounds helped treat early carious lesions, with nano-hydroxyapatite being the most efficacious, warranting a strong recommendation. More clinical studies are advised in the future to assess the long-term effects of these medications.

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