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Prevention of dentine erosion by brushing with anti-erosive toothpastes

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ABSTRACT

Objective: This in vitro study aimed to investigate the preventive effect of brushing with anti-erosive toothpastes compared to a conventional fluoride toothpaste on dentine erosion.
Materials and methods: Bovine dentine specimens (n = 12 per subgroup) were eroded in an artificial mouth (6 days, 6 × 30 s/day) using either citric acid (pH:2.5) or a hydrochloric acid/pepsin solution (pH:1.6), simulating extrinsic or intrinsic erosive conditions, respectively. In between, the specimens were rinsed with artificial saliva. Twice daily, the specimens were brushed for 15 s in an automatic brushing machine at 2.5 N with a conventional fluoride toothpaste slurry (elmex, AmF) or toothpaste slurries with anti-erosive formulations: Apacare (NaF/1% nHAP), Biorepair ($ZnCO_3$-HAP), Chitodent (Chitosan), elmex Erosionsschutz (NaF/AmF/$SnCl_2$/Chitosan), mirasensitive hap (NaF/30% HAP), Sensodyne Proschmelz (NaF/KNO_3). Unbrushed specimens served as control. Dentine loss was measured profilometrically and statistically analysed using two-way and one-way ANOVA followed by Scheffe‘s post hoc tests. RDA-values of all toothpastes were determined, and linear mixed models were applied to analyse the influence of toothpaste abrasivity on dentine wear ($p < 0.05$).
Results: Dentine erosion of unbrushed specimens amounted to 5.1 ± 1.0 μm (extrinsic conditions) and 12.9 ± 1.4 μm (intrinsic conditions). All toothpastes significantly reduced dentine erosion by 24–67% (extrinsic conditions) and 21–40% (intrinsic conditions). Biorepair was least effective, while all other toothpastes were not significantly different from each other. Linear mixed models did not show a significant effect of the RDA-value of the respective toothpaste on dentine loss.
Conclusion: Toothpastes with anti-erosive formulations reduced dentine erosion, especially under simulated extrinsic erosive conditions, but were not superior to a conventional fluoride toothpaste.

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1. Introduction

The use of conventional fluoridated toothpastes was shown to be of limited efficacy in the prevention of erosive tooth wear compared to the application of high-concentrated fluoride products, especially when applied at high frequency.[1,2] However, compared to sodium fluoride-containing toothpastes experimental toothpastes containing other fluoride compounds, e.g. titanium tetrafluoride or stannous fluoride, were shown to be of higher efficacy.[3,4]

In the last years, numerous toothpastes with ''anti-erosive'' or ''repairing'' claims were marketed, which contain other active ingredients besides fluorides, e.g. hydroxyapatite nanoparticles, zinc-carbonate-hydroxyapatite nanoparticles, potassium nitrate, stannous salts, chitosan and/or proteins.

Previous studies showed that some of these toothpastes presented a higher protective potential on enamel erosion than conventional toothpastes,[5–8] while other studies failed to show this effect.[9,10] Interestingly, it was also demonstrated that the erosion-inhibiting potential of both conventional and anti-erosive toothpastes was higher when enamel specimens were just exposed to rather than brushed with the respective toothpaste slurries.[9,11] In the latter case, it is possible that brushing hampers or removes surface precipitates essential for the anti-erosive effect. It is therefore still questionable whether patients at risk for dental erosion really benefit from the use of these anti-erosive or repairing toothpastes compared to conventional fluoride toothpastes.

So far, most studies tested the erosion-protective effect of toothpastes with special formulations mainly on enamel specimens. However, considering that dentine is frequently exposed by erosion, especially in high risk patients suffering from eating disorders,[12] reflux[13] or alcohol abuse,[14] prevention of dentine erosion by home-use oral care products is becoming increasingly important.

Therefore, the aim of the study was to investigate the preventive effect of brushing with anti-erosive toothpastes compared to a conventional fluoride toothpaste on dentine erosion by simulated extrinsic and intrinsic erosive conditions. The null-hypothesis was that the erosion protective effect of anti-erosive or repairing toothpastes on dentine is not superior to a conventional fluoride toothpaste.

2. Materials and methods

2.1. Specimen preparation

2.1.1. Specimen preparation for erosive cycling

A total of 216 cylindrical dentine specimens (diameter: 3 mm) were prepared from the root surfaces of freshly extracted, non-damaged bovine incisors, which were stored in 0.1% thymol solution until they were used. The dentine specimens were prepared using a water-cooled trephine bur and embedded in acrylic resin blocks (Paladur, Heraeus Kulzer, Germany) each containing three dentine specimens. The unique shape of the resin blocks with a round tip on one end and a cornered tip on the other allowed exact repositioning of the specimens in the brushing machine as well as in the profilometer. The specimens were ground flat with water-cooled discs (1200, 2400 and 4000 grit, Water Proof Silicon carbide Paper, Struers, Erkrath, Germany) and randomly allocated to 16 groups with $n = 12$ specimens each.

2.1.2. Specimen preparation for RDA measurement

Sixty-four roots of freshly extracted bovine incisors were used. In preparation for the RDA-measurement, the root surfaces were polished under water-cooling (Sof-Lex discs, 15 μm and 3 μm, International Dental Supply, Hialeah, FL, USA) for two minutes with 40–60 g load.[15] The specimens were then radiated (Atomic Institute of Vienna, Austria) and randomly

Table 1 – Manufacturer, composition and pH-values of the toothpastes.

Toothpastes	Ingredients	LOT	pH
ApaCare Cumdente GmbH	Aqua, Hydrated Silica, Sorbitol, Propylene Glycol, Glycerin, Sodium C14-16 Olefin Sulfonate, Hydroxyapatite, Aroma, Cellulose Gum, CI 77891, Sodium Fluoride, Allantoin, Sodium Saccharin, Tetrapotassium Pyrophosphate, Limonene	AV1504	7.5
BioRepair Dr. Kurt Wolff Forschung	Aqua, Zinc Carbonate Hydroxylapatite, Hydrated Silica, Glycerin, Sorbitol, Silica, Aroma, Cellulose Gum, Sodium Myristoyl Sarcosinate, Sodium Methyl Cocoyl Taurate, Tetrapotassium Pyrophosphate, Zinc PCA, Cetraria Islandica Extract, Sodium Saccharin, Citric Acid, Phenoxyethanol, Benzyl Alcohol, Methylparaben, Propylparaben	228951114	7.9
Chitodent B&F Elektro GmbH	Aqua, Sorbitol, Hydrated Silica, Glycerin, Chitin/Chitosan, Acetic acid, Betaine, Paraffinum Liquidum, Titanium dioxide, Sodium saccharin	51922	6.0
elmex GABA	Aqua, Hydrated Silica, Sorbitol, Hydroxyethylcellulose, (Olaflur) Amine fluoride, Aroma, Limonene, Titanium Dioxide, Saccharin	22051E	5.9
elmex Erosionsschutz GABA	Aqua, Glycerin, Sorbitol, Hydrated silica, Hydroxyethylcellulose, Aroma, Cocamidopropyl Betaine, Titanium dioxide, Olaflur, Sodium Gluconate, Stannous Chloride, Alumina, Chitosan, Sodium Saccharin, Sodium Fluoride, Potassium Hydroxide, Hydrochloric Acid	21311C	5.6
Mirasensitive Hager Werken	Aqua, Hydroxyapatite, Xylitol, Sorbitol, Propylene Glycol, Potassium Citrate, Tetrapotassium Pyrophosphate, Sodium C 14–16 Olefin Sulfonate, Disodium Pyrophosphate, Cellulose Gum, Aroma, Sodium Fluoride, Cocamidopropyl Betaine, Sodium Saccharin, Limonene, CI 77891,	080814	9.2
Sensodyne Proschmelz GlaxoSmithKline	Aqua, Sorbitol, Hydrated Silica, Glycerin, Potassium Nitrate, PEG-6, Cocamidopropyl Betaine, Aroma, Xanthan Gum, Sodium Saccharin, Sodium Fluoride, Titanium Dioxide, Sodium Hydroxide, Limonene, Anise Alcohol.	381C	7.4

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