Article Analysis and Evaluation – Etiology/Other

DECLARATIVE TITLE: Teeth with mild and moderate enamel fluorosis demonstrate increased caries susceptibility in vitro.

ARTICLE TITLE AND BIBLIOGRAPHIC INFORMATION: Higher fluorosis severity makes enamel less resistant to demineralization. Marín LM, Cury JA, Tenuta LMA, Castellanos JE, Martignon S. Caries Res 2016;50:407-13.

PURPOSE/QUESTION: This study aimed at determining if the degree of hypomineralization or fluoride concentration was relevant to caries development in fluorotic enamel.

SOURCE OF FUNDING: Government: COLCIENCIAS (grant No. 2012-442) and Foundations: FUNCAMP (Conv 4252).

TYPE OF STUDY/DESIGN: Case-control study – laboratory study

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KEY WORDS: Fluorides, Dental fluorosis, Dental caries, Susceptibility

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Summary

Subjects: In this laboratory study, 49 human unerupted third molars extracted for clinical reasons and classified as scores 0 to 4 using the Thylstrup and Fejerskov (TF) index (n = 9 for TF 0, n = 10 for TF1, n = 10 for TF2, n = 10 for TF3, n = 10 for TF4) were included. TF1 to TF4 teeth were collected in Colombia, and TF0 teeth were obtained from the University of Copenhagen. Ethical approval was obtained.

Key Risk/Study Factor: Teeth in the study were subjected to pH-cycling to induce caries lesions.

Main Outcome Measure: The primary outcome measure was resistance to a cariogenic challenge determined using cross-sectional microhardness. A series of indentations, starting at 10 μm below the anatomical surface down to 200 μm, were placed in the teeth using a Knoop indenter. These measurements were performed before and after pH cycling, yielding baseline and demineralization areas, both calculated "by numerical integration of the hardness versus depth values using the trapezoidal rule." The demineralization data were then normalized for differences at baseline and a "percentage reduction" calculated, with higher numbers being indicative of greater susceptibility to caries lesion formation.

Main Results: Teeth with scores of TF3 and TF4 exhibited greater susceptibility to caries lesion formation than all other teeth, with no differences being observed between unaffected teeth (TF0) and teeth with scores of TF1 and TF2. Teeth with scores of TF3 and TF4 also displayed a lower mean baseline area than those with TF1 and TF2, although not compared to TF0 teeth, indicative of greater hypomineralization.

Conclusions: The authors concluded that the results of their study suggest that teeth with moderate fluorosis had an increased caries susceptibility when compared to teeth with very mild or no fluorosis. They hypothesized that these differences in caries susceptibility are mainly due to dissimilarities in porosity of the enamel – in fluorotic teeth, a greater subsurface mineral area is exposed to demineralization and deeper acid diffusion through enamel is facilitated.

Commentary and Analysis

Marin *et al* report on an investigation that assessed the susceptibility to caries lesion formation in vitro of teeth exhibiting varying severities of fluorosis. An innovative feature of the study was the fact that the demineralization data were normalized for differences at baseline. Furthermore, potential differences in the naturally occurring mineralization status of the teeth were investigated as well as fluoride content in unaffected and fluorotic enamel.

The present study included teeth with TF scores from 0 to 4, or, in other words, unaffected teeth (TF0) and teeth with questionable (TF1), very mild (TF2-3), mild (TF3-4), and moderate fluorosis (TF4). [1] Teeth with severe fluorosis (TF5-9) were not included as "unerupted teeth do not present higher TF scores". [2] Other potential reasons are their comparatively lower prevalence combined with difficulties in obtaining sufficient quantities for research purposes (access to special populations). It can be argued that the study included teeth that represent severities that are commonly seen in optimally and negligibly fluoridated areas, and therefore their sample was of clinical relevance.

TF scores were determined by a sole examiner and the inclusion of a second examiner could have undoubtedly provided more certainty. For their statistical analysis, the authors then pooled the data for teeth with TF1-2 and TF3-4, respectively, without having provided a rationale for doing so. Bearing in mind the above-mentioned classification, this is not necessarily justifiable and it would have been beneficial to treat each study group independently.

The use of unerupted third molars allows for the direct study of fluorosis effects on caries susceptibility as it eliminates posteruptive maturation processes [3] and the potential influence of anticaries interventions. While it is of great importance from a mechanistic perspective to exclude potential confounding factors, this choice limits the clinical relevance of the authors' findings. The authors argued that their observed differences in susceptibility to caries were due to differences in porosity between fluorotic and non-fluorotic teeth. Posteruptively however, teeth mature in that they accumulate fluoride and become more mineralized due to exposure to saliva, and thus become harder, less porous, and ultimately less caries-prone. It can only be speculated if these processes are similar or not between fluorotic and non-fluorotic teeth. It appears that only a comparative study between unerupted and erupted teeth affected or not by fluorosis would be able to provide more conclusive evidence to that matter. The present results demonstrate, however, that fluorotic teeth appear to be more vulnerable to caries immediately after eruption. However, the authors excluded several data points due to extensive demineralization (1 TF0 specimen) or lack thereof (TF3 and TF4, 1 each). Given the small sample size (n = 9-10) at the beginning of the study and bearing in mind the inherent biological variability of teeth, inclusion of these data points could have potentially led to different conclusions.

There is an ongoing debate about the suitability of cross-sectional microhardness to determine the demineralization and remineralization of enamel. While good correlations have been observed for non-fluorotic teeth, [4] the present study was the first to present data for fluorotic teeth. Correlating these data to mineral content by using gold-standard techniques, such as transverse microradiography, could be a next valuable step. Hardness measurements determine a material's resistance to deformation, or, in other words, structural integrity but not necessarily mineral content. To relate the present findings on differences in hardness to differences in mineral content would require further validation.

The authors also showed in their study that fluorotic enamel contains more fluoride than unaffected enamel and that these differences are not only confined to visually detectable fluorotic enamel (typically only the outer 20 to 100 μm of enamel-present opacities), [5] since bulk fluorotic enamel was also shown to exhibit higher fluoride concentrations. Due to greater fluoride incorporation into fluorotic than unaffected enamel, it has been shown that

there are inherent structural differences between the two: potentially less mineralized interprismatic areas due to greater retention of matrix proteins in fluorotic enamel can increase porosity – an argument the authors used to explain their findings. Indeed, both inherent solubility and porosity (structure) determine caries susceptibility, [6] and the greater fluoride content of fluorotic enamel can most likely not compensate for the greater structural weakness. However, our understanding of structural differences between fluorotic and unaffected teeth is still poor. [7] The present study added to our knowledge of the effects of fluorosis on in vitro caries development; further in vitro and in vivo research will be required to better characterize fluorosed enamel susceptibility to caries lesion formation.

Strength of Recommendation Taxonomy (SORT) Grading

LEVEL OF EVIDENCE:

Level 3	Other evidence

STRENGTH OF RECOMMENDATION GRADE:

N/A	Not applicable

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