LACK OF A SIGNIFICANT RELATIONSHIP BETWEEN TOENAIL FLUORIDE CONCENTRATIONS AND CARIES PREVALENCE

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SUMMARY: The relationship between fluoride (F) concentrations in toenails and prevalence of caries using the International Caries Detection and Assessment System (ICDAS-II) criteria was evaluated. Fifty-four children (4–13 years of age) from Rio de Janeiro, Brazil, had their teeth surfaces examined and toenails clipped and analyzed for F. Toenail F concentrations in children presenting ICDAS-II$\leq$10 or $>$10 were compared by unpaired t test with Welch correction. Dichotomized data were analyzed by Fisher's exact test. Children presenting ICDAS-II$\leq$10 (n=23) had 1.85±1.32 (Mean±SD) µg/g [F]; these values were higher than children having ICDAS-II$>$10 (n=31), whose toenails had 1.58±0.78 µg/g [F], a nonsignificant difference. The sensitivity and specificity of toenail F concentrations in identifying children with ICDAS-II$\leq$10 were 0.22 and 0.77, respectively. We conclude that children with low caries prevalence tend to have higher toenail F concentrations, but the validity of this biomarker as a diagnostic tool for caries prevalence is low, possibly owing to the fact that the mechanism of action of F on caries control appears to be essentially topical.

Keywords: Brazilian children; Caries prevalence; Fluoride concentration; ICDAS-II; Toenails.

INTRODUCTION

A recent review of 29 caries detection criteria systems concluded that the majority of the current caries detection systems do not measure the disease process at its different stages.[1] More recently several new criteria systems have been proposed and evaluated, but they still vary in how the disease is measured. [2–9] Based on the work of Ekstrand et al.,[4] which tried to integrate the best features of the other caries systems,[2,3,5-8] a group of caries researchers, epidemiologists, and restorative dentists proposed a new system, named the International Caries Detection and Assessment System (ICDAS-II).[9] Before this proposal, caries detection in surveys has been performed at a cavitation level.[10] The ICDAS-II is intended to be feasible for use in epidemiological surveys and to detect cavitated and non-cavitated stage lesions with acceptable reliability.[11-13] In Brazil, 56% of 12-year-old children have dental decay and the mean DMFT is 2.1.[14] Oral and dental health programs in Brazil and in many countries are planned and based on similar data, which have considered only cavitated caries.

Since caries experience is widely viewed as being related to levels of fluoride (F) intake, the search for biomarkers of exposure to F, which are relatively easy to collect and analyze, has intensified.[15] Fingernails and toenails have been used as biomarkers of exposure to F,[16-20] since they offer a simple, noninvasive bioassay method. Since children with caries experience have generally slightly lower intakes of fluoride,[21] the aim of this study was to examine the relationship

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between F concentrations in toenails and prevalence of caries using the ICDAS-II criteria.

MATERIALS AND METHODS

Volunteers: Fifty-four healthy children (4–13 years old) were recruited in a selected Health Center, with recommended levels of F in the drinking water, in the municipality of Rio de Janeiro, RJ, Brazil. This cross-sectional study was approved by the Ethical Committee of School of Dentistry, Federal University of Rio de Janeiro, Brazil.

Dental Examinations and toenails sampling: All the children had their teeth surfaces examined by two calibrated examiners (Kappa inter-examiner = 0.72–0.80). The ICDAS-II scores for several grades of dental caries in all surfaces have previously been described in detail.[13] Ten toenails clippings from both big toes were pooled and stored at room temperature until analysis.

Analytical procedure: Each toenail clipping was cleaned briefly with deionized water using an interdental brush and then sonicated in deionized water for 10 min, dried and weighed. The F concentrations were determined after overnight hexamethyldisiloxane-facilitated diffusion[22] as modified by Whitford,[23] using an ion-specific electrode (model 9409, Orion Research, Cambridge, Mass., USA) and a miniature calomel reference electrode (Accumet, No. 13-620-79), both coupled to a potentiometer (model EA 940, Orion Research). F standards (0.0095, 0.019, 0.095, 0.190 and 0.950 µg F as NaF were prepared by serial dilution of a stock standard containing 0.1 M of F as NaF (Orion 940906). Comparison of the millivolt readings demonstrated that the F in the diffused standards had been completely trapped and analyzed (recovery 99%). The millivoltage potentials were converted to µg of F/g of sample using a standard curve with a coefficient correlation of $r > 0.99$.

Statistical Analysis: The software GraphPad InStat version 3.0 for Windows (GraphPad, San Diego, CA, USA) was used. The data are presented as mean±SD. Toenail F concentrations in children presenting ICDAS-II ≤10 or >10 were compared by unpaired *t* test with Welch correction. Dichotomized data (toenails F concentrations ≤2 or >2 µg/g) were analyzed by Fisher's exact test. This allowed calculations of sensitivity, specificity, and predictive values regarding the use of toenail F concentrations as indicators of caries prevalence. The significance level was set at 5%.

RESULTS

The results of ICDAS-II were dichotomized into two categories: ICDAS-II ≤10 and ICDAS-II >10 representing children with low and high caries prevalence, respectively.[24] Mean (±SD) toenail F concentrations in children (n=23) presenting ICDAS-II ≤10 (1.85±1.32 µg/g) were higher than levels found in children (n=31) having ICDAS-II >10 (1.58±0.78 µg/g). The difference, however, was not significant (non-paired *t* test, $p=0.38$). The corresponding 95% CIs were 1.28–2.42 and 1.29–1.87 µg/g, respectively. The Table shows the data dichotomized according to toenail F concentrations (≤2 or >2 µg/g) and ICDAS-II scores (≤10 or >10). The sensitivity and specificity of toenail F concentrations in identifying children with ICDAS-II ≤10 was 0.22 (95% CI 0.07–0.44) and 0.77 (0.59–0.90), respectively. The positive and negative predictive values were 0.42 and 0.57, respectively.

Table. Number of children according to dichotomized values for toenail F concentrations and ICDAS-II scores

Toenail [F]s	ICDAS-II	
	≤ 10	>10
≤ 2 µg/g	5	7
> 2µg/g	18	24
Total	23	31

DISCUSSION

Since nails have been used as biomarkers of exposure to F,[16-18,20,25-29] and a longitudinal study revealed that children with high caries experience have generally slightly less intakes of F,[21] the present study was designed to examine the relationship between toenail F concentrations and prevalence of caries.

In the study by Braga et al.[24] it was reported that a mean DMFT of 1.9 would be correspond to an ICDAS-II score of 7.0 in Brazilian schoolchildren. Considering that the mean DMFT at 12 years recently reported for Brazil was 2.1,[14] it was decided to adopt a cut-off point at ICDAS-II score of 10 as indicative of low or high caries experience. However, determining the caries prevalence of the children was not the aim of the present study. Our goal was to examine the relationship between toenail F concentrations and prevalence of caries assessed using ICDAS-II criteria.

Toenails were chosen instead of fingernails because they provide enough mass to be analyzed and also are usually less prone to external contamination.[16,20] Our thought was that the mean toenail F concentrations might be higher in children presenting ICDAS-II≤10 compared with those having ICDAS-II>10. This would be indicative of higher F intake in the former group, which could be expected to occur in cases of lower caries experience.[21] However, the difference did not reach statistical significance. This could be attributed mainly to the fact that although lower F intakes have been associated with higher caries experience, it is widely recognized that the mechanism of action of F for caries control occurs essentially through its topical contact with the teeth.[30] In other words, it is not necessary to ingest F to have F protection against caries. However, nail F concentrations represent the amount of F that was ingested along a period of time.[19]

In addition, when attempting to correlate toenail F concentration with ICDAS-II scores, we decided to establish a cut-off point for toenail F concentrations around 2 µg/g. This was done because it was recently reported that a significantly higher risk of developing fluorosis is observed when fingernail F concentrations are higher than 2 µg/g.[31] When this was done, no significant association between the dichotomized variables could be seen. Moreover, specificity, sensitivity, and predictive values were very low.

In conclusion, in a population of Brazilian children who had a high caries experience when the ICDAS-II index was employed, it was observed that the children with low caries prevalence tended to have only slightly, nonsignificantly higher toenail F concentrations. Thus, the validity of this biomarker as a diagnostic tool for caries prevalence is low, probably due the fact that, among various possible reasons, the mechanism of action of F on caries control occurs essentially though its local contact with the teeth.

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