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Chromatic analysis of teeth exposed to different mouthrinses

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ABSTRACT

Objectives: The aim of this study was to assess, in vitro, the color of teeth exposed to different mouthrinses for a prolonged period.
Methods: Bovine teeth were distributed in four groups: control, alcohol-containing mouthrinse (Listerine®), alcohol-free mouthrinse (Oral-B®) and chlorhexidine mouthrinse (Periogard®). The teeth were submitted to two cycles of staining and artificial aging. Color evaluation was performed with a digital spectrophotometer at the beginning of the experiment and after every cycle. Color changes were characterised using the system defined by the Comission Internationale de L'Eclairage (CIE L^*, a^*, b^*). Data were analysed using the ANOVA and Tukey's post hoc test.
Results: After the two cycles of staining and artificial aging, ΔE, ΔL and Δb from the alcohol-containing mouthrinse showed statistically significant differences when compared to the other groups. The ΔE values of the Listerine® group after the two cycles were greater than 3.7, indicating a visually perceptible color change.
Conclusions: The teeth exposed to the alcohol-containing mouthwash Listerine® were the only ones that presented a clinically perceptible color change.
Clinical significance statement: A blue-colored alcohol-containing mouthwash was shown to be capable of causing dental color change after a prolonged period of exposure. Special care must be taken when choosing and prescribing the prolonged use of the same mouthwash.

1. Introduction

The increase in aesthetic demands from patients nowadays raises questions about tooth color changes. Environmental factors like diet and chemical products may cause alterations in tooth color depending on the frequency and period of exposure.

For some decades, the use of mouthrinses has become usual in a variety of clinical situations, despite the adverse effects they may cause on oral tissues and teeth.[1,2]

Alcohol, which can be part of the composition of some mouthrinse solutions, has antiseptic properties, helps the breakage or dissolution of active principles (antimicrobial agents, especially essential oils), in addition to preserving the components of the formula, although its addition does not contribute directly to the control of biofilm and prevention of gingivitis. However, alcohol may have some unwanted effects, like lesions in oral tissues – including burning or sore sensation and mucosal peeling or stomatitis – and softening of resin composites.[3–5]

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Chlorhexidine is routinely prescribed in oral diseases. Its use is associated to numerous adverse effects, as sensitivity alteration, superficial desquamation of oral mucosa, discoloration of tongue and teeth and calculus formation.[2] Chlorhexidine is also able to denature components from the biofilm, and two accepted theories of stain formation as a consequence of its use include the formation of pigmented sulphides and precipitation of pigments present in diet.[6]The first studies on tooth color used color scales based on the subjectivity of the individual. Posteriorly, the use of a colorimeter became regular, but measurement errors were common due to limitations of the device, since it was designed to measure the color of flat surfaces and had a small opening of light entrance.[7] In the 1990s, the spectrophotometer enabled tooth color measurement through the reading of the three components of color, independently of the kind of surface studied.[7–9]

The Commission Internationale de L'Eclairage (CIE L^*, a^*, b^*)[10] defined a system of color reading. According to this system, L^* represents the luminosity axis, a^* represents the green–red axis ($-a$ = green; $+a$ = red) and b^* represents the blue–yellow axis ($-b$ = blue; $+b$ = yellow). Thus, the calculus of total color change (ΔE^*ab) is possible.

The objective of this study was to perform an in vitro chromatic analysis of labial surfaces of teeth exposed to different mouthrinses for a prolonged period.

2. Material and methods

Sixty freshly extracted bovine permanent incisors were obtained and stored in a 0.1% thymol solution for 1 week at 5 °C. Bovine teeth were selected as their enamel presents a behaviour similar to the human teeth enamel.[11,12]

The teeth were divided into four groups of 15 teeth each. One group was used as a control group and the teeth were immersed in artificial saliva. The teeth from the other three groups were immersed in their respective mouthrinse solutions, as follows: alcohol-containing (21.6%) mouthrinse – Listerine® (Tartar Control, Johnson & Johnson, São Paulo, Brazil); alcohol-free (cetylpyridinium chloride) mouthrinse – Oral-B® (Mint flavour, Procter & Gamble, São Paulo, Brazil); chlorhexidine (0.06 g) mouthrinses – Periogard® (Colgate-Palmolive, São Paulo, Brazil). The mouthrinses used in this study have numerous color options in their commercial presentations. The use of the blue color in the solutions was standardised for this study.

The teeth were submitted to two cycles of staining and artificial aging. Each cycle was characterised by storing the specimens in an aging chamber with ultraviolet light (wavelength of 254 nm), under heat (45 °C) and 65% relative humidity (according to ADA Standard no. 27) for 24 h (corresponding to 5 years) immersed in their respective solutions.

Color reading was performed on the crown middle third, in a region delimitated with four marking points made with a spherical diamond bur. This delimitation promoted a standardisation of the region assessed in all measurement periods. The teeth had their color evaluated with the portable digital spectrophotometer Vita Easyshade® Compact (VITA Zahnfabrik H. Rauter GmbH & Co. KG, Bad Säckingen, Germany – Model DEASYC220) after they were rinsed with distilled water in an ultrasonic cleaning bath and dried with tissue paper. The color evaluation was performed in three periods: initial (T1), after the first cycle (T2) and after the second cycle (T3). Three measurements were done for each tooth in each period and the mean value was considered.[1] The measurements were made in the same environment by a single operator previously calibrated. The values L, a and b were recorded for each reading. The ΔE was calculated by the following formula: $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$.

The results obtained were submitted to the Kolmogorov–Smirnov normality test. Analysis of variance (ANOVA) and the Tukey's post hoc test were used to identify intergroup differences in each interval.

3. Results

Table 1 shows the color changes (ΔE values), changes in luminosity (ΔL values) and changes in the blue–yellow axis (Δb values) of the teeth exposed to different mouthwashes. The most marked change in color (mean 7.53), the most marked change in luminosity (mean −2.82, indicating that the teeth got darkener), and the most marked change in the blue–yellow axis (mean −3.18, indicating that the teeth got bluish) after the two cycles were observed in the Listerine® group.

4. Discussion

Color perception by visual assessment is physiologically and psychologically subjective as it varies from person to person. This subjectiveness is the result of many factors, such as the position of the observed object and of the observer in relation to illumination; the color of light used for illumination; metamerism, fatigue and aging of the object; as well as the emotional state of the observer.[13] The use of a spectrophotometer excludes the errors of subjective color assessment.

The ΔE values show whether there has been discoloration between two time periods. However, it does not show exactly where this change lies. Some authors consider that color change is not visually detectable when the ΔE is lower than 3.3[14,15] and other authors adopt the threshold of 3.7.[16,17] The ΔE limit value adopted in this study was 3.7.

The Listerine® group presented the greatest ΔE values in all periods assessed, and the only ones that may represent a visually perceptible color change according to the threshold discussed. This finding was confirmed by the statistical significance of the ΔE values between the initial and the final assessment (ΔE 1/3) among the groups.

The alcohol concentration (21.6%) and the low pH in Listerine® solution may favour dental enamel demineralisation after prolonged exposure[18] and its pigmentation since discoloration and pigmentation have been reported as being possibly associated with low pH values and with enamel erosion or demineralisation.[19,20] That could justify the greatest discoloration in the Listerine® group in this study.

Chlorhexidine may precipitate diet pigments on dental surfaces.[5] As there was no use of food or diet in this study, this may justify the fact that the discoloration in the chlorhexidine group was not clinically perceptible.