Effect of Tooth Whitening with Violet LED and Peroxides on Enamel Stained with Cigarette Smoke, Coffee or Red Wine Solutions

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Abstract
Bovine dental enamel blocks were obtained and artificially stained with the extrinsic pigments (n=50): SK, CF, RW or C. Afterwards, specimens were treated with the following bleaching protocols: LED, LED/CP, CP, LED/HP and HP. Color change (ΔE) was measured considering after staining (T0), 24 hours elapsed from bleaching (TB) and 7 days after treatments (T7) times by means of digital spectrophotometry. Data was tested by two-way ANOVA and Tukey’s Test. Enamel’s surface morphology after treatments was analysed under scanning electron microscope (SEM). Type of staining and bleaching protocols significantly affected bleaching outcomes (p<0.001). Regardless of the extrinsic pigment, LED promoted statistically greater ΔE for stained groups in comparison to C (p<0.05). LED alone promoted clinical perceptible ΔE, but in less extent than for gels. LED/CP ΔE was significantly greater than CP’s for CF, RW and C (p<0.05). Equal ΔE was found for LED/CP and HP for all pigments (p>0.05), except for CF (p=0.02). Only CF led LED/HP ΔE to be significantly higher than HP (p=0.012). Seven days elapsed from bleaching, outcomes were maintained. SEM images revealed that topography of enamel bleached with gels suffered alterations, but this was not exacerbated by LED irradiation.

Key words: LED, Staining, Peroxide

Introduction
*Manufacturer indicates the use of violet LED (approximately 405nm) without any whitening gels, stating that light could absorb pigments adhered to enamel surface. However, LED is also being used combined with high-concentrated carbamide (CP) or hydrogen peroxide (HP) for patients with low or absent TS.1,2

*Therefore, the aim of this study was to evaluate the effect of cigarette smoke (SK), coffee (CF) and red wine (RW) on color alteration and surface morphology of enamel submitted to in-office whitening with violet LED combined or not with 37% carbamide (CP) or 35% hydrogen peroxide.

Results and Discussion
ΔE(T7-T0) due to the adopted protocols.

Table 1. Means values and standard deviation of ΔE (T7-T0) due to the adopted protocols.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Staining</th>
<th>Coffee</th>
<th>Smoke</th>
<th>Red Wine</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED/CP</td>
<td>30.01 (17.5) Aa</td>
<td>27.68 (10.33) Ab</td>
<td>31.27 (17.04) Aa</td>
<td>19.81 (10.03) Ab</td>
<td></td>
</tr>
<tr>
<td>HP</td>
<td>19.33 (12.03) Cab</td>
<td>27.79 (10.33) Ac</td>
<td>27.00 (13.79) Aa</td>
<td>31.48 (16.3) Ab</td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td>15.66 (5.53) Ca</td>
<td>19.06 (11.1) Aa</td>
<td>20.87 (7.86) Bc</td>
<td>8.08 (10.09) Cb</td>
<td></td>
</tr>
</tbody>
</table>

Means and standard deviations followed by distinct letters, demonstrate statistical differences after two-way ANOVA and Tukey test (5%). Upper case compare different materials with the same surface treatments in (columns). Lower case letters compare different surface treatments of the same material (p<0.05).

ΔE (TB-T0) due to the adopted protocols.

Table 2. Means values and standard deviation of ΔE (TB-T0) due to the adopted protocols.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Staining</th>
<th>Coffee</th>
<th>Smoke</th>
<th>Red Wine</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>20.17 (7.79) Ca</td>
<td>19.80 (10.89) Ba</td>
<td>19.06 (10.52) Ca</td>
<td>6.74 (3.16) Bc</td>
<td></td>
</tr>
<tr>
<td>LED/CP</td>
<td>32.83 (6.01) Aa</td>
<td>31.94 (10.18) Ac</td>
<td>31.64 (11.47) Ac</td>
<td>15.68 (6.50) Ab</td>
<td></td>
</tr>
<tr>
<td>HP</td>
<td>20.40 (4.83) Cab</td>
<td>25.38 (5.60) Ab</td>
<td>28.74 (11.82) Ab</td>
<td>15.43 (6.32) Ab</td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td>15.44 (12.74) Co</td>
<td>19.35 (12.80) Ab</td>
<td>22.37 (10.49) Bc</td>
<td>8.52 (13.35) Bc</td>
<td></td>
</tr>
</tbody>
</table>

Means and standard deviations followed by distinct letters, demonstrate statistical differences after two-way ANOVA and Tukey test (5%). Upper case compare different materials with the same surface treatments (in columns). Lower case letters compare different surface treatments of the same material (p<0.05).

*Corroborating the findings of Gallinari et al. (2019)3, LED groups promoted clinical perceptible bleaching outcomes. However, the violet light alone was more effective under the presence of extrinsic pigments.

*Therefore, the assumption that violet LED would act removing the extrinsic staining adhered to enamel espesulated by Rastelli et al. (2018)6 might be corrected.

*However, the mechanism of action responsible for increasing the effectiveness of CP under violet irradiation could be explained by the fact that light increased the temperature of the gel1, thereby increasing decomposition of hydrogen peroxide into oxygen free radical species.

Table 2. Representative Images of all protocols regardless the staining protocols

Image 2. Representative Images of all protocols regardless the staining protocols.

*As reported by Berger et al. (2009)9, who showed that blue LED and LED/Laser light sources did not, violet LED did not exacerbated the changes caused by peroxide gels.

*LED alone group presented flat surface, free of irregularities which were found in all other groups, e.g. depressions and affected inter-prismatic spaces.

Conclusions
Effectiveness of LED alone on tooth bleaching is enhanced in the presence of extrinsic pigments. Violet light activation influenced the effectiveness of CP and HP depending on staining type. LED did not change patterns of enamel surface morphology.

References