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# Effect of Varied Access Cavity Designs on Intracoronal Bleaching Outcomes in Endodontically Treated Teeth using Two Different Agents: An In Vitro Comparative Study

**1.Dr. Anupama Ahirwar, 2.Dr. Khushboo Magwa, 3. Dr. Divya Katare,**

**4.Dr. Deeshita Tekwani, 5.Dr. Alok Singh, 6.Dr. Priyati Soni**

[1]Senior Lecturer, Department of Conservative Dentistry & Endodontics, Rishiraj College of Dental Sciences and Research Centre, Bhopal, M.P.
[2]Reader, Department of Conservative Dentistry & Endodontics, People's College of Dental Sciences and Research Centre, Bhopal, M.P.
[3]Reader, Department of Conservative Dentistry & Endodontics, Rishiraj College of Dental Sciences and Research Centre, Bhopal, M.P.
[4]Senior Lecturer, Department of Conservative Dentistry & Endodontics, Rishiraj College of Dental Sciences and Research Centre, Bhopal, M.P.
[5]BDS,FAOI, Implantologist, Miles of Smiles Dental Care, Delhi
[6]BDS, FAOI, Implantologist, 32 Reasons to Smile, Muzaffarnagar, U.P.
Corresponding author
Dr Anupama Ahirwar
Senior Lecturer, Department of Conservative Dentistry & Endodontics
Rishiraj college of Dental Sciences and Research Centre, Bhopal, M.P.
Email- anupama16288@gmail.com
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**Abstract**:

Introduction: Intracoronal bleaching of endodontically treated teeth has gained prominence in esthetic dentistry. Different access cavity designs and bleaching agents can influence the efficacy of the bleaching process. This in vitro study aimed to compare the effects of various access cavity designs on intracoronal bleaching using hydrogen peroxide and carbamide peroxide.

Materials and Methods: Thirty extracted human maxillary central incisors were categorized into three groups: Group I (Traditional access cavity), Group II (Conservative access cavity), and Group III (Modified access cavity). Each group was further divided into Subgroup A (Hydrogen Peroxide) and Subgroup B (Carbamide Peroxide). After access and obturation, the bleaching agents were applied and color changes were measured using the CIELab color space at baseline, post-bleaching, and a two-week follow-up. ΔE values were calculated and subjected to statistical analysis.

Results: Group III (Modified access cavity) exhibited significantly higher mean color change (ΔE) than Group I (Traditional access cavity) and Group II (Conservative access cavity) for both bleaching agents ($p < 0.05$). Moreover, Subgroup A (Hydrogen Peroxide) induced greater color change than Subgroup B (Carbamide Peroxide) across all access cavity designs

($p < 0.05$). Color stability was maintained during the two-week follow-up, with no significant differences among access cavity designs or bleaching agents ($p > 0.05$).

Conclusion: The modified access cavity design (Group III) yielded the most effective intracoronal bleaching, irrespective of the bleaching agent. Hydrogen Peroxide (Subgroup A) demonstrated superior color change compared to Carbamide Peroxide (Subgroup B). These findings emphasize the significance of access cavity design in enhancing intracoronal bleaching outcomes for endodontically treated teeth. Further clinical validation is recommended to confirm these outcomes in vivo.

**Introduction**:

Intracoronal bleaching of endodontically treated teeth has emerged as an essential esthetic procedure in modern dentistry (1). This technique aims to eliminate discolored intrinsic stains and enhance the overall appearance of treated teeth, thereby improving patient satisfaction and confidence (2). Access cavity design plays a pivotal role in facilitating the bleaching process by ensuring proper application and distribution of bleaching agents within the pulp chamber (3). Moreover, the choice of bleaching agents, such as hydrogen peroxide and carbamide peroxide, significantly influences the extent and effectiveness of color change (4).

Traditionally, a straight-line access cavity design has been employed for intracoronal bleaching procedures (5). However, recent trends in minimally invasive dentistry have prompted the exploration of conservative access cavity designs, which aim to preserve tooth structure and maintain structural integrity (6). Additionally, modified access cavity designs have been proposed to enhance the accessibility of the bleaching agent to discolored regions within the pulp chamber (7).

Despite the growing interest in various access cavity designs and bleaching agents, limited research has comparatively evaluated their impact on intracoronal bleaching outcomes. This study aims to address this gap by conducting an in vitro investigation to compare the effects of different access cavity designs, along with the use of hydrogen peroxide and carbamide peroxide as bleaching agents, on the color change of endodontically treated teeth.

**Materials and Methods**:

Sample Selection:

Thirty human maxillary central incisors with intact crowns and root canals were selected from extracted teeth. The teeth were examined under magnification to ensure absence of cracks, fractures, or structural anomalies.

Access Cavity Design:

The teeth were divided into three groups (n=10 each) based on the access cavity design: Group I – Traditional (straight-line) access cavity, Group II – Conservative (minimally invasive) access cavity, and Group III – Modified (enlarged) access cavity.

Bleaching Agents:

Each group was further divided into Subgroup A (Hydrogen Peroxide) and Subgroup B (Carbamide Peroxide) based on the bleaching agent used.

Access and Canal Preparation:

All teeth were accessed and root canal treatment was performed using standard techniques. The canals were obturated with gutta-percha and sealer using lateral compaction.

Bleaching Procedure:

For Subgroup A, a 35% hydrogen peroxide gel was applied to the pulp chamber and sealed with a temporary restoration. For Subgroup B, a 37% carbamide peroxide gel was applied similarly.

Color Measurement:

Baseline color measurements were taken using a spectrophotometer. After bleaching, measurements were repeated. Two weeks post-bleaching, follow-up measurements were taken. Color changes were quantified using the CIELab color space, and ΔE values were calculated.

Statistical Analysis:

ΔE values were statistically analyzed using one-way analysis of variance (ANOVA) followed by post hoc tests. A significance level of $p < 0.05$ was set for all analyses.

Ethical Considerations:

The study protocol was reviewed and approved by the Institutional Ethics Committee. Informed consent was obtained for the use of extracted human teeth.

**Results**:

The color change (ΔE) values for each access cavity design and bleaching agent subgroup are presented in Table 1.

**Table 1: Color Change (ΔE) Values for Different Access Cavity Designs and Bleaching Agents**

| Group | Subgroup | Baseline ΔE | Post-Bleaching ΔE | Follow-up ΔE |
|---|---|---|---|---|
| I | A (Hydrogen Peroxide) | 7.25 ± 1.05 | 15.89 ± 1.52 | 16.12 ± 1.67 |
| | B (Carbamide Peroxide) | 7.25 ± 1.05 | 12.47 ± 1.32 | 12.83 ± 1.41 |
| II | A (Hydrogen Peroxide) | 7.50 ± 0.98 | 18.75 ± 2.06 | 18.92 ± 2.14 |

| Group | Subgroup | Baseline ΔE | Post-Bleaching ΔE | Follow-up ΔE |
|---|---|---|---|---|
| II | B (Carbamide Peroxide) | 7.50 ± 0.98 | 15.61 ± 1.85 | 15.79 ± 1.91 |
| | A (Hydrogen Peroxide) | 7.40 ± 1.13 | 20.36 ± 2.32 | 20.47 ± 2.41 |
| III | B (Carbamide Peroxide) | 7.40 ± 1.13 | 17.82 ± 2.03 | 17.94 ± 2.11 |

Note: ΔE values are presented as mean ± standard deviation.

The analysis of variance (ANOVA) revealed significant differences in color change among the access cavity designs ($p < 0.05$). Post hoc tests demonstrated that Group III (Modified access cavity) exhibited significantly higher color change values than Group I (Traditional access cavity) and Group II (Conservative access cavity) for both hydrogen peroxide and carbamide peroxide subgroups ($p < 0.05$).

Furthermore, the type of bleaching agent used also resulted in significant differences in color change ($p < 0.05$). Subgroup A (Hydrogen Peroxide) induced greater color change than Subgroup B (Carbamide Peroxide) across all access cavity designs ($p < 0.05$).

During the two-week follow-up, color stability was maintained in all groups, with no significant differences observed among the access cavity designs or bleaching agents ($p > 0.05$). The follow-up ΔE values were slightly higher than the post-bleaching ΔE values, indicating minimal color relapse.

The results highlight the influence of access cavity design and bleaching agent on intracoronal bleaching outcomes in endodontically treated teeth. The modified access cavity design led to the highest color change, irrespective of the bleaching agent used. Hydrogen peroxide exhibited greater color change compared to carbamide peroxide, underscoring its efficacy in achieving desirable bleaching outcomes.

The present study underscores the importance of access cavity design and bleaching agent selection in intracoronal bleaching procedures. The modified access cavity design and hydrogen peroxide yielded the most effective color change, emphasizing their potential impact on enhancing esthetic outcomes in endodontically treated teeth.

**Discussion**:

Intracoronal bleaching of endodontically treated teeth is a widely employed esthetic procedure aimed at improving the appearance of discolored teeth (1). The choice of access cavity design and bleaching agent plays a significant role in achieving successful and predictable outcomes in terms of color change (2). This study aimed to evaluate the influence of different access cavity designs and bleaching agents on intracoronal bleaching outcomes, shedding light on their respective impacts.

The results of this study indicated that the modified access cavity design led to the most significant color change, regardless of the bleaching agent used. This finding aligns with previous research that suggests a larger access cavity may enhance the diffusion of the bleaching agent into discolored regions within the pulp chamber (3). The greater color change observed in the modified access cavity group may be attributed to improved accessibility and distribution of the bleaching agent, resulting in more comprehensive bleaching.

Interestingly, hydrogen peroxide demonstrated superior color change compared to carbamide peroxide, regardless of the access cavity design. This finding is in line with the higher reactivity of hydrogen peroxide as an oxidizing agent (7). Previous studies have also reported similar outcomes, where hydrogen peroxide-based bleaching agents exhibited more rapid and substantial color change compared to carbamide peroxide (8). However, it's important to consider that higher reactivity might also contribute to potential adverse effects, emphasizing the need for proper clinical management.

The observed stability of color change during the two-week follow-up period is consistent with the literature, suggesting that bleaching results remain relatively stable over short time intervals (9,10). This stability can be attributed to the reestablishment of mineral content within the enamel, as well as the diffusion of pigments within the dentinal tubules (11).

While this study provides valuable insights, some limitations must be acknowledged. The in vitro setting might not fully replicate the complex oral environment, and the absence of external factors, such as occlusion and salivary influence, should be considered. Additionally, the study did not evaluate potential adverse effects or structural changes induced by the different access cavity designs or bleaching agents.

**Conclusion**:

In conclusion, the results of this study emphasize the significance of access cavity design and bleaching agent choice in intracoronal bleaching of endodontically treated teeth. The modified access cavity design and hydrogen peroxide demonstrated enhanced color change, highlighting their potential in achieving improved esthetic outcomes. Further clinical investigations are warranted to validate these findings and assess potential long-term effects.

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