Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2973-2977 | ISSN:2251-6727

A Bleaching Breakthrough or Breakage? The Impact of Carbamide Peroxide on Tooth Strength– An Ex Vivo Study

Dr. Eva Mishra[1], Dr. Seema Dixit[2], Dr. Anil Dhingra[3], Dr. Pulkit Gupta[4], Dr. Sahil Rohilla[5], Dr. Neetika Jain[6]

[1]Post Graduate Student, Department of Conservative Dentistry and Endodontics, Seema Dental College and Hospital, Rishikesh, Uttarakhand, India (Corresponding Author)

[2]Professor and Head, Department of Conservative Dentistry and Endodontics, Seema Dental College and Hospital, Rishikesh, Uttarakhand, India

[3]Professor and Head, Department of Conservative Dentistry and Endodontics, DJ College of Dental Sciences & Research, Modinagar, Ghaziabad, Uttar Pradesh, India

[4]Reader, Department of Conservative Dentistry and Endodontics, Seema Dental College and Hospital, Rishikesh, Uttarakhand, India

[5]BDS, MDS (Endodontics)

[6]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Kalka Dental College and Hospital, Meerut, Uttar Pradesh, India

Corresponding Author: Dr. Eva Mishra

(Received: 16 June 2025 Revised: 20 July 2025 Accepted: 19 August 2025)

KEYWORDS

Intracoronal Bleaching, Carbamide Peroxide, Fracture Resistance, Endodontically Treated Teeth

ABSTRACT:

Background: Intracoronal bleaching is widely employed for managing discoloration in nonvital teeth. However, concerns remain regarding its potential influence on the structural integrity of endodontically treated teeth.

Aim: To evaluate and compare the fracture resistance of endodontically treated teeth subjected to intracoronal bleaching using different concentrations of carbamide peroxide.

Materials and Methods: 60 extracted mandibular first premolars were endodontically treated, restored with a cervical barrier, and randomly divided into four groups (n=15 each). Group 1: endodontically treated teeth (Control group); Group 2: bleaching with 15% carbamide peroxide; Group 3: bleaching with 20% carbamide peroxide; Group 4: bleaching with 35% carbamide peroxide. Samples were incubated for 7 days at 37°C, followed by restoration with glass ionomer cement. Fracture resistance was tested using a Universal Testing Machine (Instron). Data were statistically analyzed.

Results: Teeth bleached with 15% carbamide peroxide demonstrated significantly higher fracture resistance compared with 20% and 35% groups ($p < 0.05$). A concentration-dependent reduction in fracture resistance was observed.

Conclusion: The findings of this ex vivo study suggest that intracoronal bleaching with higher concentrations of carbamide peroxide diminishes the fracture resistance of endodontically treated teeth. Clinicians should consider using lower concentrations to minimize the risk of structural compromise.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2973-2977 | ISSN:2251-6727

Introduction

Tooth discoloration in nonvital teeth is a frequent esthetic concern, often resulting from pulpal necrosis, trauma, or previous endodontic therapy. Intracoronal bleaching has been established as a conservative approach to restore esthetics without invasive prosthetic options[1]. Commonly used agents include hydrogen peroxide, sodium perborate, and carbamide peroxide in varying concentrations[2]. Despite its effectiveness, bleaching agents may compromise tooth structure by altering the mechanical properties of enamel and dentin. Studies have shown reduced microhardness and fracture resistance following bleaching[3,2]. Conversely, other investigations report minimal adverse effects when appropriate barriers and protocols are used[4,5]. Conflicting results necessitate further evaluation of how concentration and exposure to bleaching agents influence fracture resistance. This study was designed to assess the effect of different concentrations (15%, 20%, and 35%) of carbamide peroxide on the fracture resistance of endodontically treated teeth, testing the null hypothesis that concentration does not alter fracture resistance.

Materials and Methods

Sample Selection: 60 extracted human mandibular first premolars of similar dimensions were collected, disinfected (10% formalin, followed by autoclaving), and cleaned using ultrasonic scaling.

Endodontic Procedure: Access cavities were prepared, working length established, and biomechanical preparation carried out with Protaper Universal rotary files. Obturation was completed using gutta-percha and resin sealer. A 2 mm cervical barrier of Type II GIC was placed at the CEJ.

Grouping: Teeth were embedded in acrylic resin and randomly assigned into three groups (n=15):

- **Group A (Control):** Endodontically treated teeth.
- **Group B:** Bleaching with 15% carbamide peroxide.
- **Group C:** Bleaching with 20% carbamide peroxide.
- **Group D:** Bleaching with 35% carbamide peroxide.

Bleaching Protocol: Bleaching agents were placed intracoronally, & tooth restored with Type II GIC and then samples were incubated at 37°C and 100% humidity for 7 days. Agents were then removed, chambers rinsed, and access cavities restored with Type II GIC.

Fracture Resistance Testing: Specimens were subjected to compressive loading in a Universal Testing Machine (Instron) until fracture occurred. Maximum load (in Newtons) was recorded.

Statistical Analysis: ANOVA with **post hoc tests** was used to compare the average fracture resistance values. A **p-value** of less than 0.05 indicated a significant difference.

Results

Group 1 (Endodontically treated teeth) exhibited the highest fracture resistance, while Group 4 (35% carbamide peroxide) demonstrated the lowest. Statistical analysis revealed significant differences among the groups ($p < 0.05$), indicating a concentration-dependent reduction in fracture resistance.

Groups	N	Mean	Std. Deviation	Minimum	Maximum
Group A (Control)	15	799.9347	11.45543	781.60	824.26
Group B (15% CP)	15	771.0893	20.50407	738.53	809.16
Group C (20% CP)	15	755.2100	25.20389	707.27	786.63
Group D (35% CP)	15	718.7873	16.74791	681.93	743.89

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 2973-2977 | ISSN:2251-6727

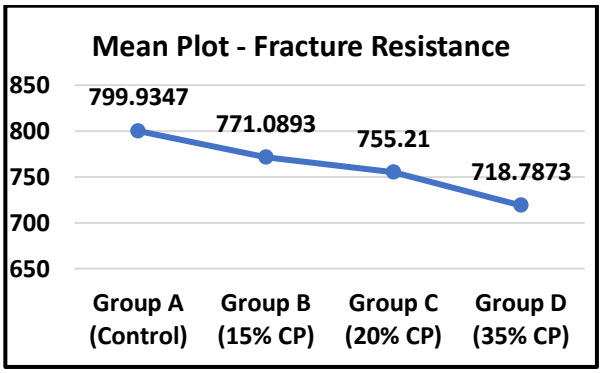

Table 1 and Graph 1 illustrate the fracture resistance values across different groups. Control group demonstrated the greatest fracture resistance with a mean of 799.9347 ± 11.45543 MPa followed by Group B (15% CP) with a mean of 771.0893 ± 20.5040 MPa. The difference noted was statistically significant at p=0.000. The least fracture resistance was observed in the group intervened with 35% CP (Group D).

Discussion

Tooth bleaching has become one of the most widely sought esthetic procedures in dentistry, with both vital and non-vital techniques being extensively employed to manage discolorations (9, 24). The mechanism of bleaching involves the diffusion of peroxide agents through enamel and dentin, where free radicals oxidize organic and inorganic substrates, leading to color change[10,11,18]. While this process is effective in improving esthetics, concerns remain about its potential adverse effects on tooth structure and mechanical properties[12,13]. Several investigations have reported that peroxide-based bleaching agents can reduce enamel microhardness, alter dentin composition, and compromise fracture resistance[19–22]. Attin et al. also demonstrated a reduction in fracture toughness and hardness of enamel with bleaching systems[3], while Lewinstein et al. observed decreased microhardness of enamel and dentin after exposure to peroxide agents[2]. Such effects are attributed to oxidative degradation of dentinal collagen and disturbance of the organic-inorganic balance of dental hard tissues[6]. The present study showed that intracoronal bleaching reduced the fracture resistance of endodontically treated teeth in a manner that depended on the bleaching concentration. Specimens treated with 15% carbamide peroxide demonstrated greater resistance compared to those bleached with 20% and 35%. These findings are consistent with previous reports, where both concentration and formulation of bleaching agents were shown to influence their effect on tooth structure[7,14]. According to Sulieman[9] and Li[14], higher bleach concentrations and extended exposure enhance whitening, but this comes at the cost of the tooth's structural integrity. However, not all evidence is in agreement. Leonardo et al. reported no significant reduction in fracture resistance even at higher concentrations of carbamide peroxide[4,25]. Likewise, Antony et al. and Bonfante et al. demonstrated that fracture resistance outcomes may depend more on the bleaching protocol and restorative techniques employed rather than bleaching alone[5,27]. Mehrotra et al. recently highlighted the protective role of intraorifice barriers, showing their ability to minimize bleaching agent penetration and enhance fracture resistance[26]. Such differences across studies may be attributed to variations in experimental design, tooth type, restorative approaches, and the use of protective barriers. From a clinical perspective, reviews by Zimmerli et al.[23] and Coelho et al.[16] stress the importance of balancing esthetic demands with preservation of tooth integrity. Similarly, Swift[17] and Alqahtani[18] noted that adverse effects on tooth structure and bonding are concentration-dependent and must be considered when planning treatment. The adjunctive use of light or laser activation has been reported to enhance bleaching efficacy[15], though its influence on structural compromise remains inconclusive. Taken together, the evidence indicates that intracoronal bleaching is a predictable esthetic solution but carries a potential risk of weakening tooth structure, particularly at higher concentrations and longer exposure times. The findings of this study reinforce the need for conservative bleaching protocols, use of lower concentrations, and incorporation of intraorifice barriers to safeguard tooth strength while achieving satisfactory esthetic outcomes[8,15,26].

Conclusion

Within the limitations of this ex vivo study:

- Intracoronal bleaching with higher concentrations of carbamide peroxide reduced fracture resistance.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2973-2977 | ISSN:2251-6727

- Teeth bleached with 15% carbamide peroxide showed greater resistance compared with 20% and 35%.
- Clinicians should use the lowest effective concentration of bleaching agent to balance esthetic outcomes with tooth integrity.

Further long-term in vivo studies are recommended.

References

1. Zimmerli B, Jeger F, Lussi A. Bleaching of nonvital teeth: A clinically relevant literature review. Schweiz Monatsschr Zahnmed. 2010;120:306-320.
2. Lewinstein I, Hirschfeld Z, Stabholz A, Rotstein I. Effect of hydrogen peroxide and sodium perborate on the microhardness of human enamel and dentin. J Endod. 1994;20:61-63.
3. Attin T, Müller T, Patyk A, Lennon AM. Influence of different bleaching systems on fracture toughness and hardness of enamel. Oper Dent. 2004;29:188-195.
4. Leonardo RT, Kuga MC, Guiotti FA. Fracture resistance of teeth submitted to several internal bleaching protocols. J Contemp Dent Pract. 2014;15(2):186-189.
5. Antony A, Pillai R, Varghese NO, Sujathan UN, Afzal A, George S. Fracture resistance of teeth undergoing postendodontic bleaching: Comparison of four treatment modalities – An in vitro study. Endodontology. 2019;31:150-157.
6. Tam LE, Bahrami P, Oguienko O, Limeback H. Effect of 10% and 15% carbamide peroxide on fracture toughness of human dentin in situ. Oper Dent. 2013;38:142-150.
7. Mittal R, Sood AG, Singla MG. A comparative evaluation of efficacy of commercially available bleaching agents in non-vital teeth: An in vitro study. Saudi Endod J. 2015;5(1):24-28.
8. Sakalli B, Basmaci F, Dalmizrak O. Evaluation of the penetration of intracoronal bleaching agents into the cervical region using different intraorifice barriers. BMC Oral Health. 2022;22:266.
9. Sulieman, M, 2005, 'An overview of bleaching techniques: 2. Night guard vital bleaching and non-vital bleaching', Dental Update, vol. 32, no. 1, pp. 39-46.
10. Kwon SR, Wertz PW. Review of the Mechanism of Tooth Whitening. J Esthet Restor Dent. 2015;27(5):240-257.
11. Joiner A. Tooth colour: A review of the literature. J Dent. 2004;32(Suppl 1):3-12.
12. Watts, A & Addy, M, 2001, 'Tooth discoloration and staining: a review of the literature', British Dental Journal, vol. 190, no. 6, pp. 309-316.
13. Addy M, Moran J. Mechanisms of stain formation on teeth, in particular associated with metal ions and antiseptics. Adv Dent Res 1995; 9: 450-456
14. Li, Y. (2013). Tooth whitening: What we now know. The Journal of Evidence-Based Dental Practice, 13(2), 91-96.
15. Lo Giudice, R.; Pantaleo, G.; Lizio, A.; Romeo, U.; Castiello, G.; Spagnuolo, G.; Lo Giudice, G. Clinical and Spectrophotometric Evaluation of LED and Laser Activated Teeth Bleaching. *Open Dent. J.* 2016, *10*, 242–250.
16. Coelho C, Garrido L, Garrido M, Mota M. Non-Vital Tooth Bleaching Techniques: A Systematic Review. *Coatings*. 2020;10(1):61.
17. Swift EJ Jr: Critical appraisal: effects of bleaching on tooth structure and restorations, part II: enamel bonding. J Esthet Restor Dent. 2008, 20:68-73.
18. Alqahtani MQ: Tooth-bleaching procedures and their controversial effects: a literature review . Saudi Dent J. 2014, 26:33-46.
19. Basting RT: Enamel microhardness and shear bond strength after treatment with an 18% carbamide peroxide bleaching varnish. Am J Dent. 2007, 20:324-8.
20. Ambrosano GM, Heymann HO, Pimenta LA: Microhardness evaluation of in situ vital bleaching on human dental enamel using a novel study design. Dent Mater. 2005, 21:1059-67.
21. Sasaki RT, Arcanjo AJ, Flório FM, Basting RT: Micromorphology and microhardness of enamel after treatment with home-use bleaching agents containing 10% carbamide peroxide and 7.5% hydrogen peroxide. J Appl Oral Sci. 2009, 17:611-6.
22. Tam LE, Bahrami P, Oguienko O, Limeback H: Effect of 10% and 15% carbamide peroxide on fracture toughness of human dentin in situ. Oper Dent. 2013, 38:142-50.
23. Zimmerli B, Jeger F, Lussi A: Bleaching of nonvital teeth. A clinically relevant literature review.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2973-2977 | ISSN:2251-6727

Schweiz Monatsschr Zahnmed. 2010, 120:306-20. 24.

24. Fasanaro TS: Bleaching teeth: history, chemicals, and methods used for common tooth discolorations. J Esthet Dent. 1992, 4:71-8.
25. Leonardo Rde T, Kuga MC, Guiotti FA, et al.: Fracture resistance of teeth submitted to several internal bleaching protocols. J Contemp Dent Pract. 2014, 15:186-9.
26. Mehrotra, A., Singh, S., Podar, R. S., Shetty, R., Salgar, A., & Kumar, M. (2023). An in vitro comparative evaluation of intraorifice barriers and bleaching agents on the fracture resistance of endodontically treated anterior teeth. J Conserv Dent Endod, 26(6), 646-650.
27. Bonfante G, Kaizer OB, Pegoraro LF, do Valle AL. Fracture resistance and failure pattern of teeth submitted to internal bleaching with 37% carbamide peroxide, with application of different restorative procedures. J Appl Oral Sci. 2006 Aug;14(4):247-52.