In vitro action of various carbamide peroxide gel bleaching agents on the micro hardness of human enamel

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Abstract

Aims and Objectives: The study was undertaken to evaluate the effects of different carbamide peroxide based gels on micro hardness of enamel exposed to these agents for a period of 8 h daily for a total of 1 week. Materials and Methods: Thirty enamel specimens of 5 x 5-mm dimensions were sectioned from labial surface of maxillary incisor teeth and were embedded in Bakelite. Each block is polished to facilitate micro hardness testing. Pre-bleaching hardness values of 30 samples were measured using Vickers micro hardness tester. After exposing the specimens for different agents for 8 h daily for 1 week, post-exposure micro hardness values were taken and evaluated. Conclusion: With increase in concentration of carbamide peroxide gel from 10% to 16%, mean micro hardness values decreased but to an insignificant level.

Keywords: Carbamide peroxide gel, micro hardness, vital bleaching

Introduction

Discoloration of teeth forms an important concern to both patient and dentist as they are esthetically objectionable and can have a tremendous impact on an individual. Discoloration could be due to extrinsic or intrinsic stains.[1] Several conservative methods of treating such discoloration have evolved like acid abrasion, bleaching using hydrogen peroxide, and carbamide peroxide, which forms a viable option to consider when treating intrinsically stained or discolored teeth whose form and integrity are deemed acceptable.

To counteract the disadvantage of hydrogen peroxide, an alternative method of vital bleaching (night guard vital bleaching) using 10% carbamide peroxide delivered in custom-fitted mouth tray was discovered by Klusmier.[2] Haywood and Heyman described it in 1989 for the first time.[3] This technique offered the possibility of whiter teeth to a wider range of population at a lower cost with much less danger and fewer side effects than any of the previous options. Major disadvantage of these esthetic enhancement procedures is alteration of chemical structure of tooth.

Although dentin and enamel show a slight decrease in calcium and phosphorous after bleaching, which Feagin et al. reported would decrease the Knoop hardness value,[4] most of the authors have shown conflicting results on adverse effects of carbamide peroxide. Seghi and Denri found a change in human enamel micro hardness.[5] Pinhiero et al, found a decrease in human enamel micro hardness values, which fell into statistically intermediate values.[6]

This study was undertaken to evaluate the effect of carbamide peroxide-containing bleaching agents on change in micro hardness of sound human enamel.

Aims and objectives

The aims and objectives of the study were:

• To know whether carbamide peroxide bleaching gels have got any effect on the surface micro hardness of sound human dental enamel when exposed to 8 h daily for 1 week.
• To compare the effect of four carbamide peroxide based gels on surface micro hardness of sound human enamel when exposed daily for 8 hours for 1 week.
• To know whether an increase in percentage of carbamide peroxide further decreases the micro hardness values.

Materials and Methods

Thirty samples of maxillary central incisors were collected from the age group of 16 to 21 years for uniformity, which were free of caries and surface cracks and were stored in de-ionized water at room temperature until further use.

Stick–on papers of 5 x 5-mm dimensions were cut and placed on the labial aspect in the center of the coronal portion of each specimen. They were then highlighted with black sketch. Coronal portion of each specimen was separated...
from radicular portion at the cement–enamel junction with a double-faced diamond disc. The remaining portion of the crown, which was not highlighted, was removed with diamond disc. Highlighted papers were then removed and all the specimens were mounted in Bakelite. Purpose of Bakelite base was to provide orientation and lateral stabilization for the specimens during hardness measurement. All the specimens were placed in a bowl containing de-ionized water to dissipate heat and to prevent dehydration of specimens. Each specimen was then polished with 400, 500, and 600-grit emery paper in order to obtain smooth and uniform surface, with running water to avoid enamel injuries. It was followed by polishing with diamond paste of 0.55-µm and 3-µm using automated polisher, to get a mirror finish essential for better visualization of indentation due to hardness tester.

Mounted and polished specimens were then numbered from 1 to 30 and divided into six groups, group A to group F, each group consisting of five specimens, which are as follows

- **Group A**: Specimens 1–5
- **Group B**: Specimens 6–10
- **Group C**: Specimens 11–15
- **Group D**: Specimens 16–20
- **Group E**: Specimens 21–25
- **Group F**: Specimens 26–30

All the samples were kept in petri-dishes containing artificial saliva. Preliminary pre-bleaching surface hardness values were taken and these specimens were exposed to respective agents, Group 1 to Group 6.

- **Group 1**: Opalescence – 10% (Ultra Dent)
- **Group 2**: Nite White – 10% (Discus Dental)
- **Group 3**: Karisma Alpha – 10% (Confidential Products)
- **Group 4**: Perfect Smile – 10% (Pro – Health Product)
- **Group 5**: Nite White – 16%
- **Group 6**: Artificial saliva

Group A – Numbering 1 to 5 exposed to group 1 Opalescence – 10%
Group B – Numbering 6 to 10 exposed to group 2 Nite White – 10%
Group C – Numbering 11 to 15 exposed to group 3 Karisma Alpha – 10%
Group D – Numbering 16 to 20 exposed to group 4 Perfect Smile – 10%
Group E – Numbering 21 to 25 exposed to group 5 Nite White – 16%
Group F – Numbering 26 to 30 exposed to group 6 artificial saliva

The specimens were then exposed to their respective solutions for 8 h daily and then washed with de-ionized water and placed in petri-dishes containing artificial saliva for the remaining 16 hrs. This procedure was carried out on all the specimens for a period of 1 week.

Each specimen was cleaned with cotton swab dampened with acetone. Micro hardness tester was standardized for Vickers hardness. According to the manufacturer’s instructions, each test specimen was placed on the test base and observed through the fitted microscope for selecting an area of indent. The Vickers hardness indenter was fitted with 200 g load, which resulted in an adequate size of indentation with minimum splintering and crunching of the test specimen [Figure 1].

For each specimen, a total of five indentations before exposure and five indentations after 1 week of exposure were taken, and the average of these values was taken as hardness of the specimen. The micro hardness values for all the groups were computed separately and submitted for statistical analysis.

**Results**

Comparison of mean micro hardness values of prebleaching and 1 week post bleaching values [Table 1]. Comparison of mean micro hardness values of pre, post Vickers hardness number [VHN] in between groups [Table 2]. Components of artificial saliva [Table 3].

**Discussion**

Vital bleaching using 10 % carbamide peroxide was first discovered by Klusmier in 1960’s. This technique went relatively unnoticed until Haywood and Heyman described the technique in March 1989.

Although the decrease in discoloration with 10% carbamide

| Group | Pre-bleaching VHN | Post-bleaching VHN | t-value | Probability | Inference |
|-------|-------------------|--------------------|---------|-------------|-----------|
| A     | 400.20 ± 11.33    | 398.56 ± 11.93     | 1.938   | 0.065       | N.S       |
| B     | 399.72 ± 8.82     | 396.76 ± 5.46      | 2.034   | 0.053       | N.S       |
| C     | 399.00 ± 7.87     | 397.20 ± 11.05     | 1.486   | 0.150       | N.S       |
| D     | 399.60 ± 5.80     | 396.16 ± 11.41     | 2.045   | 0.052       | N.S       |
| E     | 396.20 ± 6.99     | 393.00 ± 7.59      | 5.358   | 0.000       | H.S       |
| F     | 396.04 ± 8.27     | 399.92 ± 11.15     | -2.024  | 0.054       | N.S       |

N.S – Non-Significant; H.S – Highly Significant; VHN: Vickers hardness number
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Table 2: Comparison of mean micro hardness values of pre, post Vickers hardness number [VHN] in between groups

|                      | Sum of squares | Df | Mean square | F-value | Probability | Inference |
|----------------------|----------------|----|-------------|---------|-------------|-----------|
| VHN Pre-exposure     | 429.260        | 5  | 85.852      | 1.230   | 0.298       | N.S       |
| Between groups       | 10054.00       | 144| 69.819      |         |             |           |
| Total                | 10483.260      | 149|             |         |             |           |
| VHN Post-exposure    | 683.413        | 5  | 138.683     | 1.373   | 0.0238      | N.S       |
| Between groups       | 14549.920      | 144| 101.041     |         |             |           |
| Total                | 15243.933      | 149|             |         |             |           |

Table 3: Components of artificial saliva

| Substance    | Concentration gm/L |
|--------------|--------------------|
| Na₂HPO₄      | 0.26               |
| NaCl         | 6.70               |
| KscN         | 0.33               |
| KH₂PO₄       | 0.20               |
| NaHCO₃       | 1.50               |
| KCl          | 1.20               |

peroxide was satisfactory, because the procedure involves direct contact of the whitening agent on the outer enamel surface for an extended period of time, evaluation of the potential adverse effects of these agents becomes essential. The prominent side effects of concern include pulpal sensitivity and surface compositional changes.[7]

Compositional changes that include de-mineralization or loss of mineral content from the outer tooth structure alter enamel micro hardness. Feagin[4] et al. reported that the decrease in hardness number is directly related to mineral loss under conditions of mild de-mineralization. Kolouri and Reed[4] found that there is a linear relationship between measured hardness of enamel and mineral loss under a wide range of de-mineralizing conditions. Seghi and Denry[7] found a decrease in human enamel micro hardness after application of 10% carbamide peroxide.

Current studies, examining the adverse effects of carbamide peroxide, have shown conflicting results and focused primarily on surface damage of the enamel. The present study is conducted on 30 extracted maxillary incisors to evaluate the effect of different carbamide peroxide bleaching agents and artificial saliva on micro hardness of the human enamel. Igor Potocnik in 2000 utilized Vickers hardness indenter to determine the micro hardness values of the specimens.[5]

Results of the present study show that in group A to group E, the mean micro hardness values decreased from pre-bleaching values to 1 week post bleaching values. When paired t test was used for comparison, it was found that there was decrease in mean values; the decrease found was to be non-significant except for group E where it was significant with P-value less than 0.01. Haywood et al. in 1991 postulated that carbamide peroxide being unstable will disassociate into 7% urea and 3% hydrogen peroxide.[8] While hydrogen peroxide degrades into water and oxygen, urea degrades into ammonia and carbon dioxide, which would raise the pH value. Murchison et al. in 1992[9] concluded that in short-term regimens 10% carbamide peroxide does not significantly affect the enamel surface.

In the present study, comparative analysis between group B exposed to 10% carbamide peroxide and group E exposed to 16% carbamide peroxide showed non-significant decrease with P greater than 0.05. Although the decrease in micro hardness values between pre- and post-bleaching for group E was more than group B, which showed that with increase in percentage of carbamide peroxide there was no significant increase in micro hardness values. This could be due to the fact that the increase in percentage of carbamide peroxide might cause an increased de-mineralization effect but the degradation of carbamide peroxide increases the pH and the re-mineralizing potential of artificial saliva would counteract the de-mineralization effect of carbamide peroxide.

Igor Potocnik in 2000[5] conducted a study exposing six freshly extracted teeth to bleaching gel containing 10% carbamide peroxide with pH of 6.62 for a time period of 336 clinical hours, changing every 8 hours. Analysis showed no significant difference between bleached and control sites. Whereas in the present study exposure time was 56 clinical hours and the pH value of the specimens were ranging from 5.9 to 6.75 except for the pH of 16% carbamide peroxide resulting in insignificant decrease in mean micro hardness values.
Jose Augusto Rorigues in 2001 evaluated the effect of opalescence and Rembrandt after 8 h of daily exposure for 42 days. Results showed no significant change in micro hardness values until seventh day after which Opalescence showed increase in hardness values. This variation has been attributed to the re-mineralizing effect of artificial saliva, which was used as storage media, but in the present study, group F exposed to artificial saliva continuously for 1 week showed increase in micro hardness values.

Catharina zantner et al. conducted a study to evaluate the influence of different home bleaching procedures on micro hardness of enamel and stated that both types of bleaching agents and concentrations have a significant influence on the micro hardness of enamel.

Roberta Tarkany Basting, Antonio Luiz et al. conducted a study on carbamide peroxide bleaching agents and concluded that different concentrations of carbamide peroxide agents result in decrease in enamel micro hardness. A post-bleaching period in artificial saliva resulted in recovery of baseline micro hardness values or an increase in values.

The results of the present study indicates that short-term regimens of carbamide peroxide at lower concentrations of 10% although reduced the micro hardness values, the reduction was insignificant. Moreover, the decrease in micro hardness has been confined to the outer 25 µm of enamel, which does not cause many problems. The re-mineralizing effect of saliva and early degradation of carbamide peroxide to ammonia, which increased the pH value, will overcome any demineralization potential of 10% carbamide peroxide.

**Conclusion**

Within the limitations of the present study, it is concluded that although there was decrease in micro hardness values from group A to group E, from pre- to post-bleaching values, the decrease was found to be non-significant in group A to group E exposed to 10% carbamide peroxide bleaching agents, but this difference was found to be significant in case of group E exposed to 16% carbamide peroxide. When compared with control group, the micro hardness values for all the groups showed significant decrease although the difference in between groups was found to be insignificant.

With increase in concentration of carbamide peroxide gel from 10% to 16%, mean micro hardness values decreased but to an insignificant level.

**References**

1. Zalkind M, Arwaz JR, Goldman A, Rotstein J. Surface morphology changes in human enamel, dentin and cementum following bleaching: A scanning electron microscopy study. Endod Dent Traumatol 1996;12:82-8.
2. Haywood VB. History, safety and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. Quintessence Int 1992;23:471-88.
3. Leonard RH Jr, Bentley CD, Haywood VB. Salivary pH changes during 10% carbamide peroxide bleaching. Quintessence Int 1994;25:547-50.
4. Shannon H, Spencer P, Gross K, Tira D. Characterization of enamel exposed to 10% carbamide peroxide bleaching agents. Quintessence Int 1993;24:39-44.
5. Seghi RR, Denny I. Effects of external bleaching on indentation and abrasion characteristics of human enamel in vitro. J Dent Res 1992;71:1340-4.
6. Potocnik I, Kosec L, Gaspersic D. Effect of 10% carbamide peroxide bleaching gel on enamel microhardness, microstructure and mineral content. J Endod 2000;26:203-6.
7. Robertson WD, Melfi RC. Pulpal response to vital bleaching procedures. J Endod 1980;6:645-9.
8. Haywood VB, Heymann HO. Night guard vital bleaching: effect of various solutions on enamel texture and colour. Quintessence Int 1991;22:775-82.
9. Murchison DF, Charlton DG, Moore BK. Carbamide peroxide bleaching efficacy on enamel surface hardness and bonding. Oper Dent 1992;17:181-5.
10. Zantner C, Beheim-Schwarzbach N, Neumann K, Kielsbass AM. Surface microhardness of enamel after different home bleaching procedures. Dent Mater 2007;23:243-50.
11. Basting RT, Rodrigues Jr AL, Serra MC. Effect of different conc of carbamide peroxide bleaching agents on micro hardness of enamel. J Am Dent Assoc 2003;10:1335-42.

How to cite this article: Sunil CR, Sujana V, Choudary TM, Nagesh B. In vitro action of various carbamide peroxide gel bleaching agents on the micro hardness of human enamel. Contemp Clin Dent 2012;3:193-6.

Source of Support: Nil. Conflict of Interest: None declared.