INTRODUCTION

In recent years, patients’ demands for esthetic treatments have increased because of the smile which plays a chief role in social communication thus the demand for a brighter and beautiful smile has grown exponentially.1,2

Tooth discoloration is classified as intrinsic, extrinsic and a combination of both, so severe mechanical, biological and chemical changes damage the esthetic equilibrium of a smile.3-5 For more obstinate extrinsic and intrinsic stains, various methods are available such as crowns, veneers and enamel micro- and macro-abrasion. Tooth bleaching technique is one of the most conservative, esthetic and ideal solutions which has gained high patient acceptance.6,7

Modern bleaching agents are either Hydrogen Peroxide (HP), Carbamide Peroxide (CP) and Sodium Perborate (SP).8 During the process of bleaching, HP acts as an active oxidizing agent. It converts the carbon double bond compound, which is usually yellow in color, to colorless hydroxyl group, or simply, a long yellow color organic chain into short colorless chain.9 This oxidizing reaction is not specific because of its small molecular weight, it diffuses through the organic matrix of enamel and not only oxidizes the chromogens but also causes destruction of the enamel organic matrix.10

Enamel is made up of 96% inorganic components including crystalline calcium phosphate, hydroxyapatite crystals and 4% organic component including protein and water. The mechanical properties of the enamel depend upon the ratio between these components. Organic content plays an important role in the bleaching process. In the presence of decomposition catalysts, enzymes and saliva, the hydrogen peroxide ionization process occurs and the free radicals diffuse through the inter prismatic substance of enamel thus opening the highly pigmented carbon rings and converting them into

chairs. Furthermore, low pH of the bleaching agents causes changes in the mineral content of the enamel and dentine resulting in weakening of mechanical property.  

For determining the enamel and dentine mechanical properties, surface micro-hardness test is a simple and commonly used method. The controversial findings and limitations in existing literature reviews have helped to set the objectives of this research work. The objective of current study was to determine the effect of home-use bleaching agent containing 16% carbamide peroxide and in-office bleaching agent containing 38% hydrogen peroxide on enamel micro-hardness. As adequate knowledge regarding different bleaching methodologies as well as their implication are paramount for clinicians in order to select the best available products and technology, this research with clear methodology and accurate approach will help dental care professionals to understand the effects of different bleaching agents with different concentrations on surface micro-hardness of enamel.

The hypothesis tested of the current study was to access the change in enamel micro-hardness after application of different concentration of bleaching agents.

**METHODOLOGY**

This current experimental study was conducted at Department of Operative Dentistry and Science of Dental Materials at Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, Karachi. Micro-hardness evaluation was carried out at Material Engineering Department of NED University of Engineering and Technology, Karachi from July to December 2014.

**Preparation of the enamel slabs:** Forty-five sound human third molars were stored in thymol solution (Buffered 0.1%, pH 7.00) for about one week; storage and handling of extracted teeth were done according to ISO/TS 11405. Hard and soft deposits were removed with ultrasonic scaler. Only crowns of the teeth without any carious lesion, cracks and pre-treatment (chemical agent) were used in this study. The longitudinal sections were made using diamond disk in digital low speed cutting saw (MTI Corp., USA) with 100 gm of load and 5 second dwell time. In each specimen, three measures were expressed in terms of mean ± standard deviation. One way ANOVA was run to test the difference in micro-hardness among different groups.

Data were entered and analyzed in Statistical Package of Social Sciences (SPSS) version 16.0. Descriptive measures were expressed in terms of mean ± standard deviation. One way ANOVA was run to test the difference in micro-hardness among different groups. Effect of bleaching in micro-hardness over different time intervals with different bleaching agents was tested by Repeated Measure Analysis of Variance (RMANOVA).

**RESULTS**

Comparisons based on different bleaching materials, before the application of bleaching agent, the average micro-hardness of enamel slabs in Group 1 was 181.1 ±9.3, in Group 2 was 180.4 ±10.1 and for Group 3, it was 174.0 ±22.9. Statistically, insignificant difference was found in between micro-hardness of teeth (p = 0.153).
One day after the application of bleaching agent the values of micro-hardness for Group 1 and 2 were 180.5 ±9.3, 179.7 ±10.0. Micro-hardness of Group 3 was 173.4 ±23.1. However, the difference among values of micro-hardness among different materials was statistically insignificant (p = 0.159).

On day 7, the highest value of micro-hardness for Group 1 was 180.5 ± 9.47. Micro-hardness value of Group 2 was less than control but higher than group 3. For Group 3, the micro-hardness was reached up to 169.7 ±29.7. Nevertheless, on day 7, the difference was also statistically insignificant (p = 0.208).

The difference in micro-hardness values among different bleaching agents was again insignificant (p = 0.118). However, the reduction of micro-hardness in Group 1 was comparatively more than Group 2. Micro-hardness of teeth was not significantly changed due to bleaching on varying time intervals (0.091). Similarly, different bleaching agents had no significant effect on them (p = 0.142). Details are given in Table III.

### DISCUSSION

Alterations in the mineral content of enamel and dentin might occur due to the acid properties of bleaching materials and their components. Such alterations may be estimated by micro-hardness tests, as performed in the present study. Enamel hardness depends on many factors such as enamel prisms and enamel tuft variations in different areas of enamel, degree of enamel mineralization, presence of any structural defects in the enamel, type of the teeth (whether it is anterior or posterior) and technique for preparing the specimens to perform the hardness test. Some other factors affecting enamel hardness are the bio-environmental factors, fluoridation of the drinking water, age of the teeth, medical conditions and different eating habits in different societies. We have used convenient sampling in this study, therefore, these factors did not have any negative effects on our results.

For in vitro studies, saliva and de-mineralized water was considered to be an ideal storing solutions. In present study, we have also used the neutral pH artificial saliva because it causes no surface changes on enamel as well. Moreover, pH and the mineral content of saliva can protect the enamel surface from possible negative effect through storage time in vitro.

Sasaki et al. and McCracken et al. have shown that there was no change in the value of micro-hardness on the surface of enamel after bleaching with carbamide peroxide or hydrogen peroxide. The results of the current study were similar as there was no significant difference found in the value of micro-hardness after bleaching with 16% carbamide peroxide and 38% hydrogen peroxide. Hence, it was in agreement with the results of Robson and McCracken. Hardness in general is associated with a salivary remineralization process, and remineralization potential exists in saliva substitutes that contain calcium and phosphate as in this study. Therefore, the artificial saliva used as a storing solution has ability to repair possible demineralization that can take place during the bleaching procedure.

It was observed in current study that the micro-hardness of human enamel, subjected to bleaching agents containing 16% carbamide peroxide or 38% hydrogen peroxide, remained constant after 14 days of treatment as was the finding of Mahringer and his colleagues and Maia and colleagues. We have found that the greater bleaching effect on enamel surface was in the...
first hour of bleaching, mainly on the organic part of enamel. The storage time in artificial saliva (till the end of study) was sufficient to repair the demineralization defect on enamel surface, as the samples were stored in artificial saliva after every bleaching cycle. Furthermore, calcium-phosphate precipitation was occurred inside the porous enamel, a process that maintains micro-hardness of enamel surface. 

Parnian and colleagues have concluded that no significant changes were observed in enamel surface micro-hardness after the application of bleaching, in agreement with the findings of current study, as the shorter period of enamel contact with bleaching agent, used in this study, did not reduce micro-hardness. Similar results were obtained by Rodrigues and colleagues that the use of In-office and at-home bleaching agents did not result in any change in enamel surface micro-hardness.

Smidt and colleagues have suggested reduction in enamel surface micro-hardness following treatment with three different 10% CP (6 hours/day for 16 days) products. These results were in disagreement with the results of present study. This difference might be due to the fact that pH of products they used were in the range 4.3 - 5.5. They also did not mention about the storage procedure in between and after the bleaching procedures which might have not aided in remineralization for artificial saliva, as happened in this case.

Hairul in 2005 has reported the reduction in surface micro-hardness of enamel following 24-hour of treatment with 30% HP solution. The results of current study was not in agreement with the result of Hairul study, because the pH of their solution was not declared and was likely to be of an acidic nature since commercial HP solutions were highly acidic to maintain long-term stability.

On the whole, majority of the studies concluded that HP and CP containing products have no significant harmful effects on enamel surface micro-hardness, even if one of the highest concentrations of HP or CP is used. The few contrasting studies that do show an effect, in general, have some limitations in the in vitro methodologies used which do not reflect the in vivo situation accurately or use products/solutions that are highly acidic.

CONCLUSION

On the basis of these results and within the limitations of this study, several conclusions can be drawn. But there was no statistical difference in micro-hardness of enamel after bleaching with different compositions in different time intervals.

REFERENCES