

## Effects of an In-office Bleaching System (ZOOM™) on Pulp Chamber Temperature *In Vitro*

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### Abstract

**Aim:** Several new techniques and materials for in-office bleaching have been introduced recently. The aim of this *in vitro* study was to measure the temperature increase in the pulp chamber of extracted teeth produced by the Zoom!™ in-office bleaching system and to investigate the influence of this light in conjunction with the bleaching gel on pulp temperature rise.

**Methods and Materials:** Ten extracted, caries-free, unrestored human maxillary central incisor teeth were used for the study. The root of each tooth was cut approximately 2-3 mm apical to the cemento-enamel junction (CEJ), and the apical orifice of the root canal was enlarged. The remaining pulp tissue was removed and the empty pulp chamber was filled with a heat sink compound. A thin K-type thermocouple was inserted into the pulp chamber through the cut root area. The root surfaces of the teeth were partially submerged in a water bath during the testing procedure at 37°C. A whitening gel containing 25% hydrogen peroxide was applied to the buccal surfaces of all ten teeth and exposed to a Zoom!™ activation light for twenty minutes for three times; this was designated as Group I. The same teeth were then exposed with the Zoom!™ light for the same time period without the application of the bleaching gel and designated as Group II.

The intrapulpal temperature pre-treatment (baseline) and the temperature increase during treatment was measured for both treatment groups.

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**Results:** There was a statistically significant difference between the two groups ( $p=0.003$ ). Application of the Zoom!<sup>TM</sup> light in conjunction with the application of bleaching gel produced a greater temperature rise than did the light alone. The mean temperature rise for Group I (light and bleaching gel) was 1.11°C (0.18°C) and 1.01°C (0.12°C) for Group II (light alone) at the end of a five-minute exposure.

**Conclusion:** The Zoom!<sup>TM</sup> light either used with or without bleaching gel showed no significant increase in the intrapulpal temperature of teeth when used for the recommended exposure time.

**Keywords:** In-office bleaching system, pulp chamber temperature, Zoom!<sup>TM</sup>

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## Introduction

Tooth bleaching has become one of dentistry's most popular esthetic services as it is the most conservative treatment for discolored teeth.<sup>1-2</sup> The bleaching of teeth using peroxide is now widely recognized as a safe and effective method for tooth bleaching and has become a routine dental procedure.<sup>3-4</sup> This procedure can be performed either in the office by a dental professional or at home by the patient. There are several types of products available for use at home that can either be dispensed by the dentist or purchased over-the-counter. Power bleaching is an in-office bleaching technique developed to bleach teeth in a single office visit with a whitening agent such as peroxide used with or without an auxiliary such as light or heat.<sup>5-6</sup> In-office bleaching systems using a light in conjunction with peroxide rely on a high intensity light source to activate the bleaching agent. By absorbing thermal energy from the light, the disassociation of oxygen from the peroxide is improved which facilitates penetration into the enamel matrix to increase the bleaching effect.

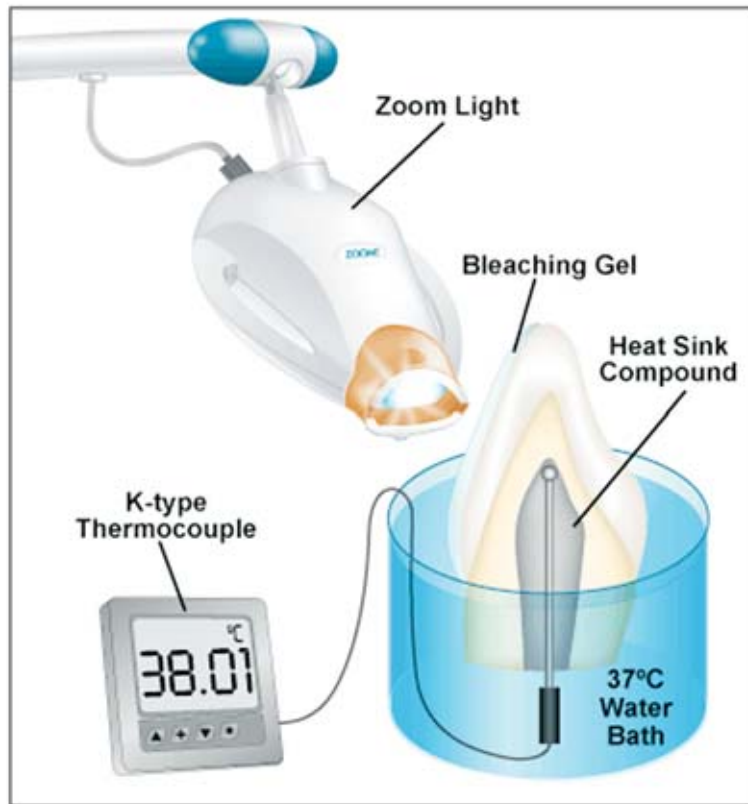
The main advantages of this system include: bleaching is totally under the dentist's control, the soft-tissue is more protected during the procedure, and the teeth bleach more quickly. Recently several new techniques and materials for in-office bleaching have been introduced. The Zoom!<sup>TM</sup> Chairside Teeth Whitening System (Discus Dental, Inc., Culver City, CA, USA) is one power bleaching system that consists of a mercury halide lamp filtered to emit light in the 350-400 nm range.<sup>7</sup> At the completion of the in-office whitening treatment, additional peroxide gel is usually given to the patient to continue the bleaching process at home and reverse color relapses.



External heat applied to teeth can cause pulpal trauma of varying degrees depending on the magnitude and duration of the temperature rise.<sup>8</sup> Zach and Cohen<sup>9</sup> reported irreversible pulpal damage occurred in 15% of monkeys' teeth when pulpal temperature increased more than 5.5°C. Several studies have shown light curing units produce heat during operation.<sup>10-12</sup> Tooth sensitivity is the most common side effect of bleaching<sup>13</sup> and raises concern energy sources like lasers, plasma arc lights, and infrared lamps that activate peroxide formulations may induce a temperature rise harmful to the pulp tissue causing the sensitivity. Therefore, the aim of this *in vitro* study was to measure the intrapulpal temperature increase produced by the Zoom!<sup>TM</sup> in-office bleaching system and to investigate the influence of the light in conjunction with the application of the bleaching gel.

## Methods and Materials

Ten extracted, caries-free, unrestored human maxillary central incisor teeth stored in a phosphate-buffered saline solution containing



**Figure 1.** Schematic drawing of the experimental set up.

0.2% sodium azide were used for the study. After the teeth were polished with pumice to remove any surface debris or contaminants, they were stored in distilled water until used. The root of each tooth was cut 2-3 mm apically to the cementoenamel junction (CEJ), and the apical orifice of the root canal was enlarged. The remaining pulp tissue was removed from the canal, and the empty pulp chamber was filled with heat sink compound (American Oil and Supply Co., Newark, NJ, USA) which replaced the pulp tissue as a heat conducting medium. A thin K-type thermocouple (Pyrometer Instrument Company, Windsor, NJ, USA) was inserted into the pulp chamber through the cut root area. The thermocouple was placed at the most coronal level of the pulp chamber, and its position was checked using radiography. The root surfaces of the tooth were partially submerged in a water bath ( $37 \pm 0.1^\circ\text{C}$ ) during the testing procedure. This method effectively stabilized the internal baseline temperature at  $37^\circ\text{C}$  and was done to minimize the effects of ambient temperature changes and to provide a consistent initial temperature for each data set (Figure 1).

The same ten teeth were treated under two different conditions and, thus, divided into two experimental groups. In group I approximately a 1-2 mm thick layer of 25% hydrogen peroxide bleaching gel was applied to the buccal surfaces of the teeth. Then the Zoom!™ light was positioned according to the manufacturer's instructions using the integral bite appliance guide to set the distance between the teeth and the light source (~2.50 inches). The teeth were exposed with the light for 20 minutes three times. After each 20-minute session, the bleaching gel was rinsed off and reapplied. To minimize the effects of heating, the next measurement was started after the tooth had cooled down to the starting temperature of  $37^\circ\text{C}$ .

In group II the same teeth were exposed with the Zoom!™ light without application of the bleaching gel. The temperature at the pulp before treatment (baseline) and temperature increase during exposure to the light was measured for both treatment modalities. As with Group I, three measurements were taken for each application for each tooth.

Table 1. Mean temperature rises.

Groups	Mean Temperature Rise (°C)			
	5 Minutes	10 Minutes	15 Minutes	20 Minutes
Zoom light+ bleaching gel (Group I)	1.11(0.18)	0.98(0.18)	0.77(0.2)	0.53(0.23)
Zoom light (Group II)	1.01(0.12)	0.82(0.15)	0.6(0.2)	0.44(0.18)

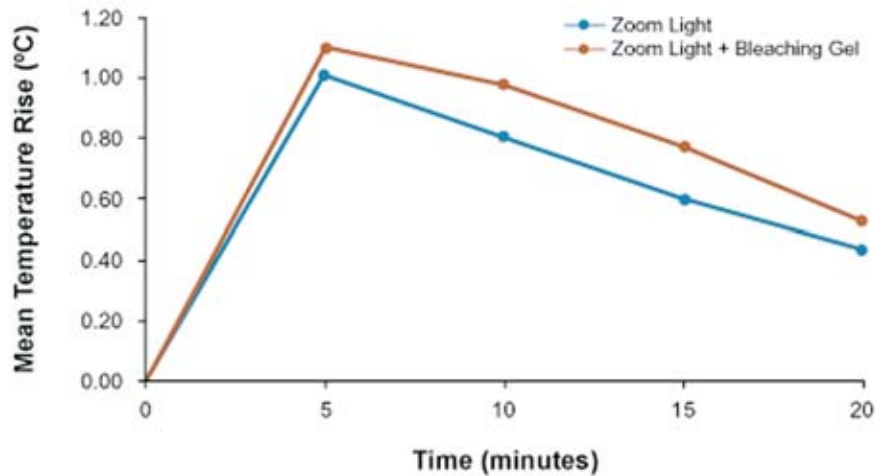


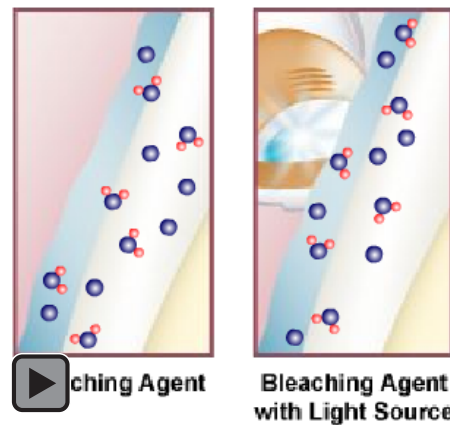
Figure 2. Pulp chamber temperature versus time curves caused by irradiation using the Zoom!™ light with and without the application of bleaching gel.

## Results

The mean temperature rises for both groups are shown in Table 1. Analysis of variance (ANOVA) revealed there was a statistically significant difference between the two groups ( $p=0.003$ ). Application of Zoom!™ light in conjunction with the application of bleaching gel produced a greater temperature rise than did the light alone. The interaction between the groups and time was insignificant ( $p=0.124$ ). At the fifth minute, the mean intrapulpal temperature rise was  $1.11^{\circ}\text{C}$  (0.18) in group I where the Zoom!™ light was used with the bleaching gel and  $1.01^{\circ}\text{C}$  (0.12) in group II using only the Zoom!™ light (Figure 2). The maximum temperature rise was seen in the first five minutes of the treatment for both groups then the temperature decreased.

## Discussion

The use of bleaching agents has become popular due to an increased interest in whiter tooth appearance. However, the exact mechanism of action is not completely understood. Hydrogen peroxide has a low molecular weight and,



therefore, diffuses through the organic matrix of the enamel and dentin.<sup>14-15</sup> During bleaching, hydrogen peroxide creates an oxygenation process on the tooth surface that acts to break the bonds of staining molecules in tooth structure. When combined with a light source, the process of tooth bleaching may be accelerated. It is thought the light triggers a quicker degradation of the peroxide into its reactive components including oxygen free radicals.<sup>16</sup> On the other

hand, there are some concerns whether bleaching gel can be equally effective in lightening the teeth without heat and light. While some studies<sup>17-18</sup> concluded lights did not lighten teeth more than bleach gels alone and teeth were lightened to nearly the same degree, others<sup>5,19</sup> reported the application of light significantly improved the whitening efficacy of bleaching materials. In a clinical study by Tavares et al.<sup>5</sup> the in-office application of gas plasma light in conjunction with the application of bleaching gel produced a significantly greater tooth bleaching effect than did the use of either light or a bleaching agent alone. They concluded light augments the effect of peroxide tooth bleaching and even light had a tooth bleaching effect by itself.

In the present study a mercury metal halide Zoom!<sup>TM</sup> light was used. The wavelength of the light emitted from this unit is in the range of 350-400 nm; meaning the light has a violet coloration. Lights may cause a temperature increase within the pulp chamber that may harm the pulp and moreover cause sensitivity.<sup>20</sup> Eldeniz et al.<sup>21</sup> measured temperature rise induced by bleaching gels when the tooth was exposed to different types of curing units. They obtained temperature values exceeding 5.5°C which has been stated as a critical temperature for histopathological changes and pulp tissue damage.

However, in the present study the Zoom!<sup>TM</sup> light was found to cause only a slight increase in the temperature as this unit has an infrared filter. This is significant because filtering infrared emissions helps to minimize the amount of heat generated at the surface of the teeth during the bleaching treatment. Sulieman et al.<sup>22</sup> examined

the surface and intra-pulpal temperature increases generated by a selection of lights used as part of the bleaching process. Similar to our findings, they reported the increase in the intrapulpal temperature with most bleaching lamps was below the critical threshold of a 5.5°C. The temperature increased when a light was used in conjunction with a bleaching agent in the present study. However, Sulieman et al.<sup>22</sup> reported the addition of the bleaching gel to the system reduced the magnitude of the rise in temperature.

Baik et al.<sup>23</sup> investigated the effect of presence, absence, and aging of a colorant added to bleaching gel on the temperature rise of the gel itself and intrapulpal temperature rise within the pulp chamber induced by a variety of light-curing units. They found the freshness of the bleaching agent and incorporating light-activated, heat-enhancing colorant influenced temperature rise of bleaching gel and increased intrapulpal temperature values.<sup>23</sup> They also concluded the use of intense lights elevates the bleach temperature and results in an increased intrapulpal temperature. However, intrapulpal temperatures were all significantly lower than those recorded in the bleaching gel.

### Conclusion

Zoom!<sup>TM</sup> light either used with or without bleaching gel did not show a significant increase in the intrapulpal temperature of teeth when used for the recommended exposure time. Since the results obtained were *in vitro*, long-term clinical trials are needed to fully understand the reasons of hypersensitivity and performance of this new whitening system.

## References

1. Papathanasiou A, Bardwell D, Kugel G. A clinical study evaluating a new chairside and take-home whitening system. *Compend Contin Educ Dent* 2001; 22: 289-297.
2. Donly KJ, Donly AS, Baharloo L, Rojas-Candelas E, Garcia-Godoy F, Zhou X, Gerlach RW. Tooth whitening in children. *Compend Contin Educ Dent* 2002; 23: 22-27.
3. Burrell KH. ADA supports vital tooth bleaching-but look for seal. *J Am Dent Assoc* 1997; 128(suppl):3S-5S.
4. Haywood VB, Heymann HO. Nightguard vital bleaching. *Quintessence Int* 1989; 20: 173-176.
5. Tavares M, Stultz J, Newman M, Smith V, Kent R, Carpino E, Goodson JM. Light augments tooth whitening with peroxide. *J Am Dent Assoc* 2003; 134: 167-175.
6. Nathanson D. Vital tooth bleaching: sensitivity and pulpal considerations. *J Am Dent Assoc* 1997; 128: suppl: 41S-44S.
7. Discus Dental:Information on file.
8. Lisani VF, Zander HA. Thermal injury to normal dog teeth: in vivo measurements to pulp temperature increases and their effect on the pulp tissue. *J Dent Res* 1952; 31: 548-558.
9. Zach L, Cohen G. Pulp response to externally applied heat. *Oral Surg Oral Med Oral Pathol* 1965; 19: 515-530.
10. Danesh G, Davids H, Duda S, Kaup M, Ott K, Schafer E. Temperature rise in the pulp chamber induced by a conventional halogen light-curing source and a plasma arc lamp. *Am J Dent* 2004; 17: 203-208.
11. Vandewalle KS, Roberts HW, Tiba A, Charlton DG. Thermal emission and curing efficiency of LED and halogen curing lights. *Oper Dent* 2005; 30(2): 257-264.
12. Yazici AR, Muftu A, Kugel G, Perry RD. Comparison of temperature changes induced by various light curing units, in vitro. *Oper Dent* 2006;31(2): 261-265.
13. Blankenau R, Goldstein R, Haywood VB. The current status of vital tooth whitening techniques. *Compendium* 1999; 20: 781-794.
14. Bowles WH, Ugwuneri Z. Pulp chamber penetration by hydrogen peroxide following vital bleaching procedures. *J Endod* 1987; 13:375-377.
15. Bowles WH, Thompson LR. Vital bleaching: the effect of heat and hydrogen peroxide on pulpal enzymes. *J Endod* 1986; 12:108-112.
16. Hein DK, Ploeger BJ, Hartup JK, Wagstaff RS, Palmer TM, Hansen LD. In-office vital tooth bleaching – what do lights add? *Compend Contin Educ Dent* 2003; 24: 340-352.
17. Jones AH, Diaz-Arnold AM, Vargas MA, Cobb DS. Colorimetric assessment of laser and home bleaching techniques. *J Esthet Dent* 1999; 11(2): 1187-94.
18. Clinical Research Associates. Why resin curing lights do not increase tooth lightening. *CRA Newsletter* 2000; 24(8):3.
19. Luk K, Tam L, Hubert M. Effect of light energy on peroxide tooth bleaching. *J Am Dent Assoc* 2004; 135(2): 194-201.
20. Goodis HE, White JM, Andrews J, Watanabe LG. Measurement of temperature generated by visible light-cure lamps in an in vitro model. *Dent Mater* 1989; 5: 230-234.
21. Eldeniz AU, Usumez A, Usumez S, Ozturk N. Pulpal temperature rise during light-activated bleaching. *J Biomed Mater Res B Appl Biomater* 2005; 72(2):254-9.
22. Sulieman M, Addy M, Rees JS. Surface and intra-pulpal temperature rises during tooth bleaching: an in vitro study.*Br Dent J* 2005; 199(1):37-40.
23. Baik JW, Rueggeberg FA, Liewehr FR. Effect of light-enhanced bleaching on *in vitro* surface and intrapulpal temperature rise. *J Esthet Restor Dent* 2001; 13(6): 370-378.

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