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Retrospective Cohort Study of Immediate Effect of Blue Light on the Dental Pulp

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Abstract

Statement of problem: This retrospective cohort study was carried out to study the effect of blue light on the dental pulp during the composite curing.

Purpose: Histological and histochemical examination of dental pulp of non caries teeth extracted for orthodontic treatment of young age patients.

Material and methods: The present study included 18 sound teeth indicated for extraction for orthodontic treatment. Class v prepared in all the teeth, 14 filled with light-cured composite, and four left unfilled (control). All 18 teeth were then extracted individually. Its pulps were investigated histologically by H & E and histo chemically for alkaline Phosphatase, acid Phosphatase, and succinic dehydrogenase.

Results: The results were as follows: Increased alkaline Phosphatase, acid Phosphatase, and succinic dehydrogenase activity were shown by all the pulp tissue except a decrease alkaline phosphatase reaction blood avascular wall of the pulp of teeth exposed to light. The increased enzymatic reaction in the pulp tissue with fibroblastic hyperplasia and vasodilation supported the irritatory and not inflammatory effect on the dental pulp.

Conclusion: The blue light has a definite histological and injurious histochemical effect on the pulp tissue. This histochemical effect demonstrates the expected harmful effect that will be demonstrated histologically later on.

Keywords: Pulp tissue; Retina; Senile macular; Alkaline Phosphatase; Acid Phosphatase; Odontoblastic layer; Control specimen

Introduction

Visible light sources have a broad peak in the visible range between 400 and 600 nm. Even though visible light higher in the spectrum and is therefore considered safer for the eyes. Many clinicians experience showed after image or eye strain when using these light units that light with a wavelength of less than 500 nm may contribute to the premature aging of the retina and too senile macular degeneration (the decreasing ability of the macular region of the retina and too senile macular region of the retina to provide visual acuity) [1,2]. Different light-cured units, despite being on the low end of the potential harm or the high end of discomfort, are sufficient to at least impair visual performance for a short period or perhaps even to inflict permanent ocular damage [3]. The council of dental materials (1985) [4] stated that operators working with the light-curing unit should wear a protective filtering device, eyeglasses, or eye shield while curing light-activated resin composite. Heat omitted during the cure of the composite end with the hypothesis that visible light cure lamps may cause a temperature increase in the pulp chamber that harms the dental pulp itself [5]. Applied enzyme histochemistry is a useful technique which can be used to elucidate changes occurred in cell organelles when expected harmful effect on the pulp cells pathological conditions. It also elucidates normal physiological and biochemical activities that undergo in normal tissues. As such, these changes could not be perceived in routine histopathological studies [6]. It is noticed that some cases complained of post-operative sensitivity of teeth after filling with light-cured composite [7] .

Aim of the Work

The aim was to study the reactivity and organization of the connective tissue of the dental pulp and the changes of the tissue colloids during the biological effect of blue light of the light cure units used polymerize composite resin filling material.

Material and Methods

Eighteen sound upper premolars were selected for this study from the orthodontic department, indicated for immediate extraction, Faculty of Dentistry, Alexandria University. Class V cavities were prepared in all the teeth' dentin provided the gingival wall 1mm occlusal to the cervical line. Mesially and distally, the cavities extended to the axial line angles. Fourteen of these teeth were filled with light-cured composite following the etch and rinse total-etch technique. The composite was applied on the mesial part of Class V and cured for 40 seconds and then on the distal part and cured for 40 seconds. The whole cavity was filled, contoured, and cured for 40 seconds. The composite filling was over cured for 20 seconds. Each tooth subjected to the blue intensified light was 140 seconds sequentially. The remaining four teeth are not filled and considered as control where teeth are prepared but not filled. The eighteen filled and unfilled teeth were extracted, and the pulps of these teeth were subjected to the following classification:

a) Group I: Four pulps of the teeth that were prepared, not filled, and not subjected to light were divided into.

i. Subgroup A: Pulps of two teeth of Group I were subjected to histological examination.

ii. Subgroup B: Pulps of the other two teeth of Group II were subjected to histochemical examination.

b) Group II: Fourteen pulps of the teeth that were prepared, filled with composite resin, and light-cured were divided into.

i. Subgroup C: Seven pulps of Group I was subjected to histological examination.

ii. Subgroup D: The seven remaining pulps of Group II were subjected to histochemical examination.

The histological and histochemical techniques that were applied as follows:

Histological study

The pulp of the two pulps of (subgroup A) and the seven pulps of (subgroup II C) were carefully detached and fixed in 10% formal saline and processed to get 6-micron thick paraffin sections for the histological study where haematoxyline and eosin stain was used.

Histochemical study

The pulp of the two teeth of (subgroup B) and seven teeth of subgroup D were carefully detached, immediately frozen, and cut by cryostat into 10-micron thick sections.

Frozen sections were incubated in each appropriate substrate for the following enzymes:

a) Subgroup B 1- Alkaline Phosphatase.

b) Subgroup B 2-Acid Phosphatase

c) Subgroup B 3-Succinic Dehydrogenase

i. Subgroup D 1- Alkaline Phosphatase

ii. Subgroup D 2-Acid Phosphatase

iii. Subgroup D 3-Succinic Dehydrogenase

Results

Histological results

a) Subgroup A: The histological pulps tissue that was not subjected to light showed a moderate number of connective tissue cells (mainly fibroblast) and a small number of blood vessels (Figure 1). While the odontoblastic layer showed a moderate number of cellular layers (Figure 2).

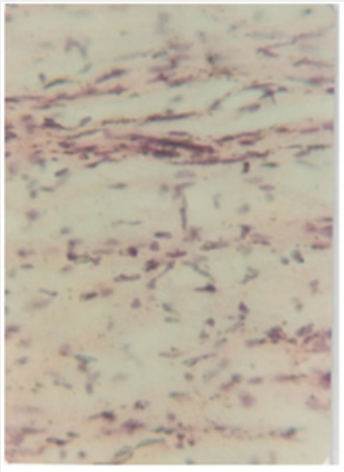

Figure 1: Group I, Subgroup A (Control pulp) H&E stain showing connective tissue cells and blood vessels are of moderate number. (x 400).

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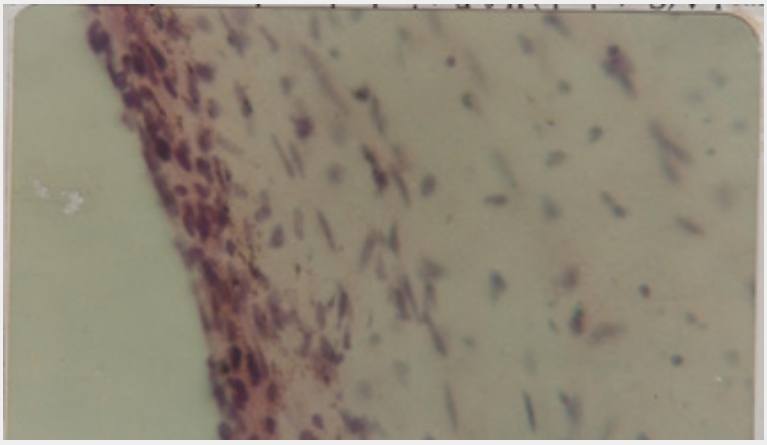

Figure 2: GroupI Subgroup A: (H&E stain) HIstological examination showing moderate number of odontoblastic layers.

b) Subgroup C: The histological pulp tissue of the seven specimens revealed evident dilatation of blood vessels (Figure 3) with an increase in the number of connective tissue cells, mainly fibroblast (Figure 4). The odontoblastic layer showed an increase in its thickness and numerous blood capillaries between its cells (Figure 5).

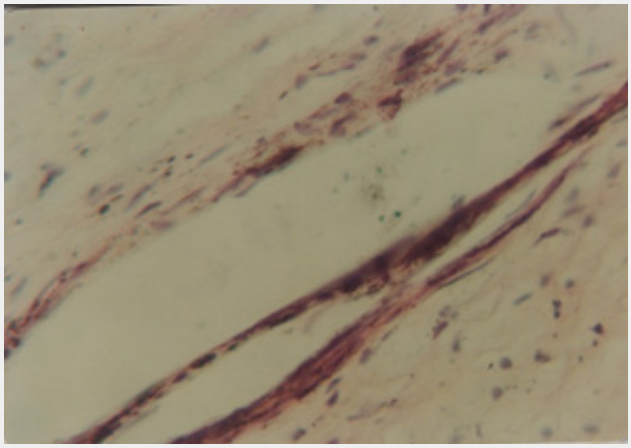

Figure 3: Group II: Subgroup C: H&E stain showing Dilated blood vessels.

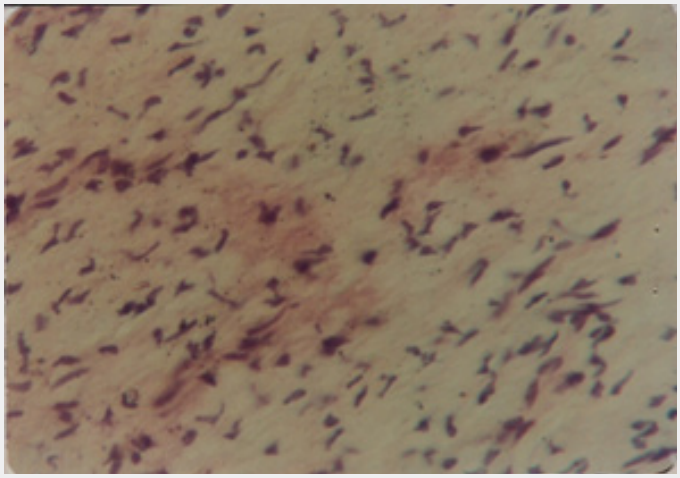

Figure 4: Group II Subgroup C: H&E stain showing Increase in number of connective tissue cells maily fibroblast(X400).

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Histochemical results

Alkaline phosphatase

a) Subgroup B1: (Control specimen) When incubated in alkaline Phosphatase, the blood capillaries' endothelial lining showed moderate enzymatic activity. The thin odontoblastic layer showed an intense reaction, and some of the connective tissue cells showed a muted reaction (Figure 6 & 7).

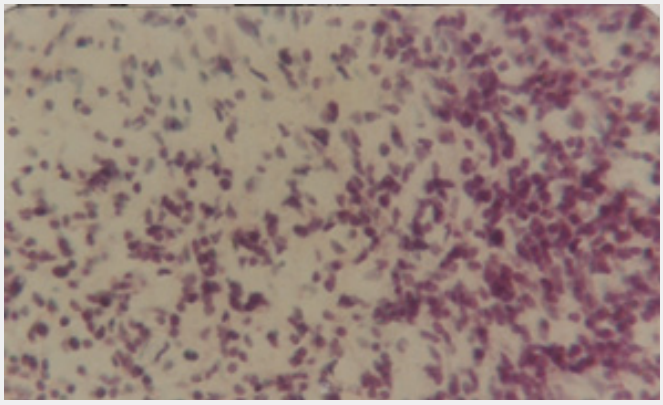

Figure 5: Group II Subgroup C: H&E stain showing marked increase in the thickness of odontoblastic layer with numerous blood capillaries in between the cells.

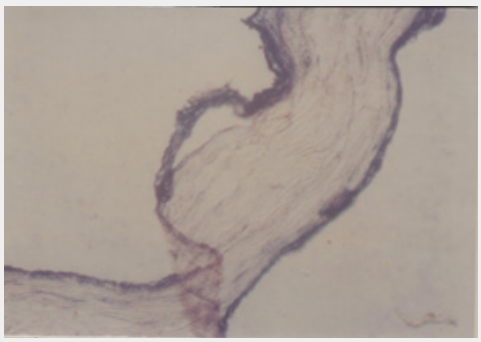

Figure 6: Group 1 Subgroup B1: Control pulp alkaline phosphatese showing moderate reaction with the odontoblastic layer.

b) Subgroup D1: When incubated in alkaline Phosphatase, the blood endothelial cells lining of the blood capillaries showed decreased enzymatic activity. A strong and heavy enzymatic reaction of the odontoblastic layer was detected. The increased reaction was noticed in the fibroblast (Figure 8).

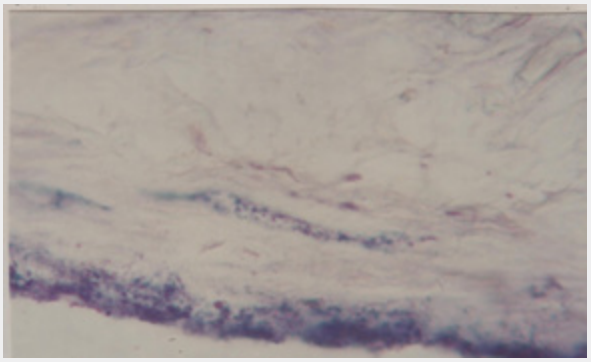

Figure 7: Group 1 Subgroup B 1: Higher magnification of the previous slide showing increase alkaline phosphatase reaction in the odontoblastic layer and in blood capillaries with the connective tissues. The fibroblast showing faint reaction(X400).

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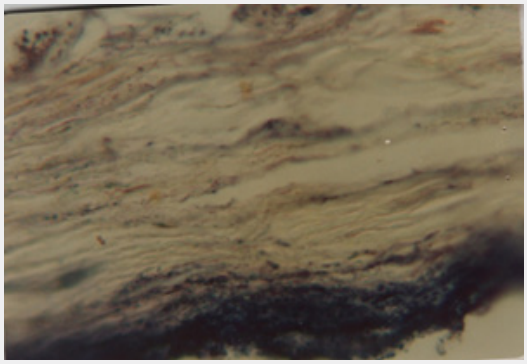

Figure 8: Group II,subgroup D 1 showing alkaline phosphatase and heavy reaction in the thick odontoblastic layer. The endothelium lining the blood vessels showed evident decrease in enzymatic activity. The fibroblast showing some increase in enzymatic reaction (x 400).

Acid phosphatase

a) Subgroup B 2. That incubated in acid phosphatase, pulps showed faint acid phosphatase reaction in the pulp's connective tissue, but the odontoblastic layer showed moderate enzymatic activity (Figure 9).

b) Subgroup D2. That incubated in acid phosphatase, pulps showed some increase in acid phosphatase activity (Figure 10).

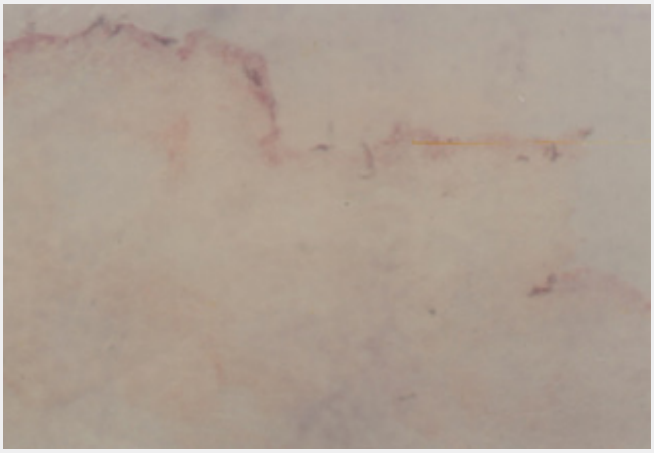

Figure 9: Group 1 subgroup B 2:control pulp acid phophatase enzyme,showing very week reaction in the connective tissue of the pulp and moderate activity in the odontoblastic layer(x150).

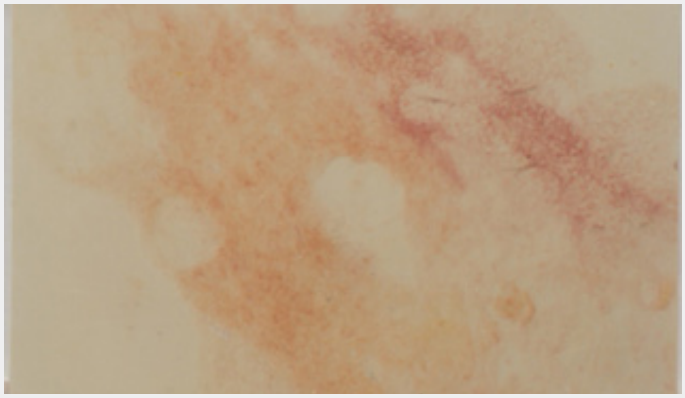

Figure 10: GroupII, SUBGROUP D2: (Pulp of teeth filled with composite), acid phosphatase enzyme showing some increased enzymatic activity (x 150).

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Succinic dehydrogenase

a) Subgroup B 3: That incubated in succinic dehydrogenase showing moderate succinic dehydrogenase activity in the odontoblastic layer and fainter in the connective tissue cells, mainly fibroblast (Figure 11).

b) Subgroup D 3: That incubated in succinic dehydrogenase showing an increase in succinic dehydrogenase enzyme activity mainly in the odontoblastic layer and the fibroblast of the connective tissue (Figure 12).

Figure 11: GROUP I SUBGROUP C3: Showing moderate succinic dehydrogenase activity in the odontoblastic layer and fainter in the connective tissue cells(x150).

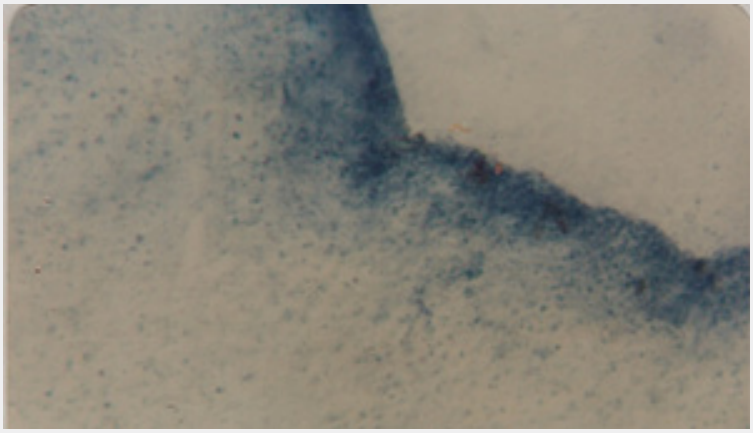

Figure 12: Group II. SUBGROUP D3 (Pulp of teeth filled with composite) showing increase in succinic dehydrogenase activity mainly in the odontoblastic layer and the fibroblast of the connective tissue (x 400).

Discussion

This study was carried out to study blue intensified fixed light on the dental pulp through exposure to light when filling class V cavities with light-cured composite. Cavities were prepared for the patient seeking orthodontic treatment, and that was indicated for extraction; cavities were filled with light-cured composite. All the precautions were carried out to no trauma transmitted to the pulp during cavity preparation. The work was divided into two parts, one with only cavity preparation and without filled with composite resin material, and the other filled with a composite resin filling material and so the difference was the result of light effect on the dental pulp. Each tooth was exposed to 140 seconds of blue light for polymerization of composite "simulating filling of the large cavity." The selected teeth were extracted. The pulps of teeth were detached and prepared for histological and histochemical study. Histologically, the present result showed; the specimens exposed to an intensified light increase in thickness in the odontoblastic layer (hyperplasia) and the fibroblast in the pulp's connective tissue were increased in number, and lastly, vasodilatation of blood vessels was evident.

This agreed with Zhi-Chun Zhao [2]; Fumihiko Yoshino & Ayaka Yoshida et al. [8] who stated that light pollution influences

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their eyes. In the visible spectrum, short-wave blue light with a wavelength between 415 nm and 455 nm is closely related to eye light damage. This high-energy blue light passes through the cornea and lens to the retina, causing diseases such as dry eye, cataract, age-related macular degeneration. Furthermore, Isabella [9] stated that Immediate and excessive superficial wear of a recently placed resin composite generates alterations in the resin matrix by the heat produced, disturbs the post-irradiation phase polymerization, and removes the superficial layer, which theoretically obtains the highest degree of conversion. Also, Mamalis A et al. [10] investigated the effects of LED-Blue light on human skin fibroblast proliferation. Also, Ieda N et al. [11]; Yoshida A et al. [12] oxidative stress-induced hyperfunction in oral mucosal cells. In particular, the blue-light irradiation of gingival fibroblasts increases. Yoshida A [13] agreed and demonstrated temporally controlled vasodilation of rat aorta ex vivo by blue-light.

Histochemically, the present result showed that the pulp demonstrated an increase in the alkaline phosphatase activity in both the odontoblastic and fibroblast in the connective tissue where there was increased reaction reactions odontoblast of the connective tissue of the treated pulp. This agreed with Martin S et al. [14]; Zhu T et al. [15], who stated that the results of The levels of alkaline Phosphatase with the groups were irradiated with blue light were higher in every experimental group than in the control group. Noting the involvement of tissue-nonspecific alkaline phosphatase increased reaction of the alkaline Phosphatase might lead to a fibroblastic activity. Also, Abe T et al. [16]. Who found that wound healing and inflammation, fibroblasts express elevated alkaline Phosphatase; they hypothesized that the extracellular matrix environment might influence the induction of alkaline Phosphatase in fibroblasts who stated that ophthalmic research into the appearance of the blue light lesion has not ruled out the possibility that intense wavelength light (less than 500nm) may contribute to the premature aging of the retina and too senile macular degeneration and blue light also may cause the formation of cataract (fibrous degeneration of the lens).

Simultaneously, the pulps' blood capillaries showed dilatation and an evident decrease in alkaline phosphatase activity of the lining endothelium. This might be a result of the reflection of the injury of the endothelial cells. While Alonso LRJ et al. [17]. Agreed and found that the blood capillaries of pulps showed dilatation and an evident decrease in alkaline phosphatase activity of the lining endothelium. This might be a result of the reflection of the injury of the endothelial cells. This also agreed with Perticone F et al. [18], who stated a significant and robust inverse relationship between alkaline phosphatase levels and endothelium-dependent vasodilation. Also agreed with Fumihiko Yoshino F & Yoshida A [19]. Dentists should be aware that the radiation can cause various phototoxic and photoallergic reactions. The result showed that acid phosphatase increased in the pulp tissue activity, including the odontoblastic layer and the connective tissue; this might represent an injury to the pulp itself, leading to its irritation. A reaction from the part of the tissue is to cope with the product of the injury.

This agreed with Suter A [20], Who stated that acid phosphatase is a lysosomal enzyme. Moreover, H Bull et al. [21] found that identity and diversity of acid Phosphatase and the relation between acid Phosphatase and the phagocytic mechanism of the cells and human disease and clinical diagnosis. The present result showed increased activity in the succinic dehydrogenase; this might be due to mitochondrial irritation by the blue light, which might lead to multiplication and increased number of mitochrondial or their rupture resulting in releasing the succinic enzyme dehydrogenase free in the cells. This agreed with Tian P [22], who stated that Succinate dehydrogenase is a mitochondrial marker enzyme. Furthermore, Rutter J [23] stated that it plays an essential role in cell metabolism. The present study showed that the histological and histochemical picture is a sort of irritation to pulp cells, which might be due to the effect of the energy elicited by the wavelength used in blue light. This agrees with Wu J et al. [24], who stated that light induced retinal damage can be hastened by increased exposure to visible light with a wavelength of less than 500 nm. This effect is photochemical rather than thermal or structural.

In this study, the teeth selected were sound of young age with healthy pulp and when exposed to blue light showed an irritating effect on the pulp tissue quite different from that of infection. In the first, the studied three enzymes' activity showed an evident increase in the pulp tissue except in the vascular blood wall, compared to the second where alkaline Phosphatase, especially in the vascular wall, showed an evident increase. In the present study, the fibroblast showed an evident increase in number while in infection, mononuclear and polympnuclear cells are the predominant ones. The result showed increased thickness of the odontoblastic layer, which increased as a result of irritation, which, when stimulated, will lead to the formation of secondary dentin to protect the pulp. The present study demonstrated both histological and histochemical findings. The histochemical results were more manifested and supported the histological results as it appears on subcellular changes. One can expect histological changes in the pulp tissue after a long time compared to the histochemical findings. Subcellular level showing the early cellular changes. One could expect histological changes in the pulp tissue after a long time compared to the histochemical findings.

Conclusion

The blue light has a definite histological and injurious histochemical effect on the pulp tissue. The histochemical findings showed the earliest change of cells before demonstrated histologically. It is expected that increased reaction of enzymes in the odontoblastic layer might lead to increased fibroblastic activity of this layer resulting in immature dentin formation of

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fibrous origin. Increased activity of fibroblasts in the pulp tissue is an indication that this might be ended with fibrosis of the pulp. Further study to the effect of intensified light on the pulp tissue for a more extended period is needed.

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