KTP Laser on Microleakage of Compomer Restorations in Class V Restorations

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Aim: *To evaluate the effects of pulsed KTP (potassium-titanyl-phosphate) laser on decrease of dentinal microleakage of compomer restorations in primary teeth.* ***Method****: Twenty four primary molars were selected for the study. After Class V cavity preparations in buccal and lingual surfaces, teeth were divided into three groups: Group 1: Control, Group 2: 1 W KTP laser, Group 3: 1.5 W KTP laser. Then cavities were restored with compomer and teeth were thermocycled to 500 cycles, isolated and immersed in 0.5% basic fuchsin for 24 hours. Teeth were rinsed, dried, and sectioned, and microleakage was assessed by dye penetration at the occlusal and gingival surface of the teeth with stereomicroscope (40X). The data were analyzed with Kruskal-Wallis, Mann-Whitney U and Wilcoxon tests.* ***Results****: When the scores of microleakage at the gingival margins of the groups were compared, the differences among the groups were found to be statistically significant ($p<0.05$). At the occlusal margins of the groups, there were no statistical differences ($p>0.05$). Comparing the gingival and the occlusal margins in the each group, statistically significant differences existed in the Groups 1 and 3 ($p<0.05$).* ***Conclusions****: KTP laser is able to seal dentinal tubules and consequently reduce microleakage towards pulp in primary teeth.*

Keywords: *Class V cavity; KTP laser; microleakage; primary teeth*

INTRODUCTION

Microleakage of oral fluids, fluid components, and bacteria can occur at the tooth/restoration interface, causing staining and a breakdown at the restoration margins, postoperative sensitivity, secondary caries and pulpal reactions. Thus, adherence at the margins of dental restoration is an important factor in the efficiency of dental restorative materials because an intact interface prevents microleakage of bacteria and oral fluids, which is important for the prevention of dental pathology and pain.[1,2]

Several studies[3,4] have shown that sealing the dentin under restoration is very important in maintaining pulpal health. It is suggested that a reasonable seal in dentin may be achieved by laser radiation with certain criteria.[5] Since the development of ruby lasers in the early 1960s, a variety of lasers have been used experimentally and clinically in dentistry.[6] This development in laser dentistry has led to lasers' use in periodontology, preventive dentistry, restorative dentistry, endodontics, minor surgery, orthodontics, and dental laboratories.[7] The major laser types in dentistry are Er:YAG, Nd:YAG, argon, and CO_2 lasers, which have been used for soft tissue surgery, apical sterilization, and partial sealing in endodontic treatment.[8,9]

Several characteristics of the lased dentinal tissue have previously been considered advantageous for resin bonding. It was reported that laser energy produces a microscopically rough substrate surface without demineralization, melting, fusion, or sealing of the dentinal tubules by the recrystalization of the mineral component of dentine without a smear layer but with dentin surface sterilization.[10,11] Dederich[12] reported a melting effect of a laser followed by the recrystalization of dentine at the root canal wall when a Nd:YAG laser's energy was used.

The Nd:YAG laser, with a wavelength of 1064 nm, has reportedly been effective on hard dental tissues and offers a significant advantage for clinical use.[13,14] When its pulp effects were proven to be far less aggressive than the effects of the ruby laser,[15] the KTP laser emitting 532 nm and representing a frequency-doubled Nd:YAG device has been introduced primarily for tooth-bleaching procedures in dentistry, and it can be delivered through a wide range of fibers in a constant or pulsed mode.[16,17] This laser has also been used for other dental applications similar to those of the Nd:YAG laser, including root canal disinfection, treatment of dentin hypersensitivity, and soft tissue surgery;[18] however, very few reports on KTP lasers have been published in the field of dentistry. Schoop *et al* [17] and Kuştarci *et al* [19] reported that KTP laser irradiation caused a significant reduction of some pathogens. In a previous study, Tewfik *et al*.[20] reported that KTP laser irradiation led to modest increases in dentinal permeability.

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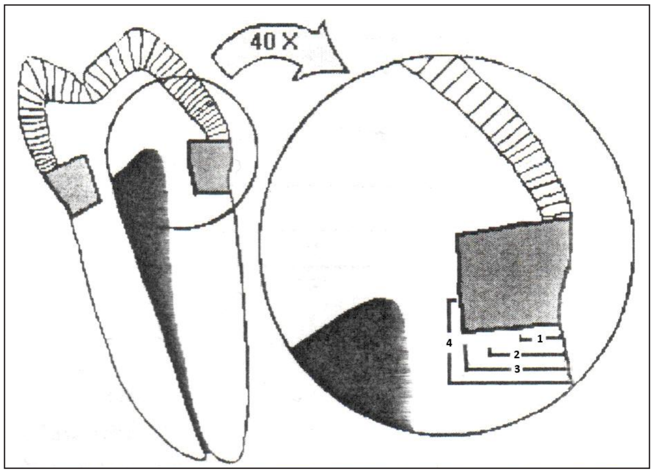

Figure 1. Schematic depiction of scores for microleakage evaluation.

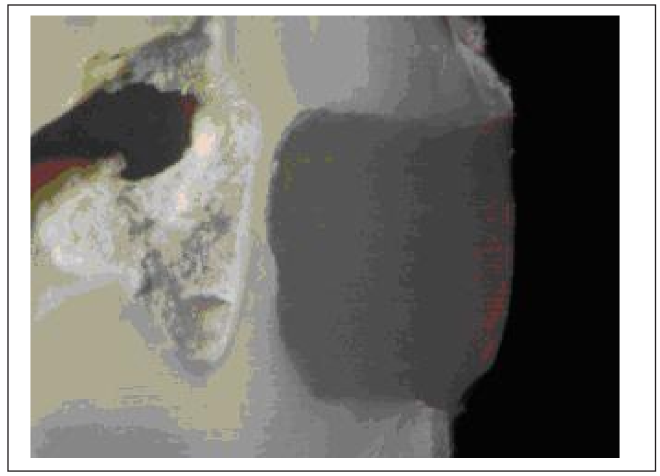

Figure 2. Photograph of the specimens with Score 0. (Group 1)

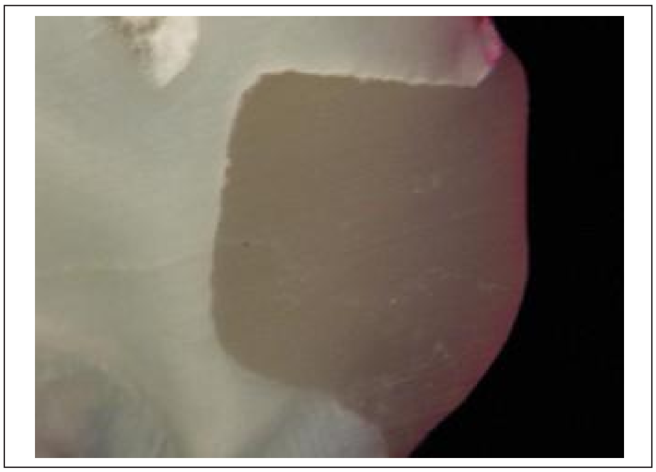

Figure 3. Photograph of the specimens with Score 1. (Group 2)

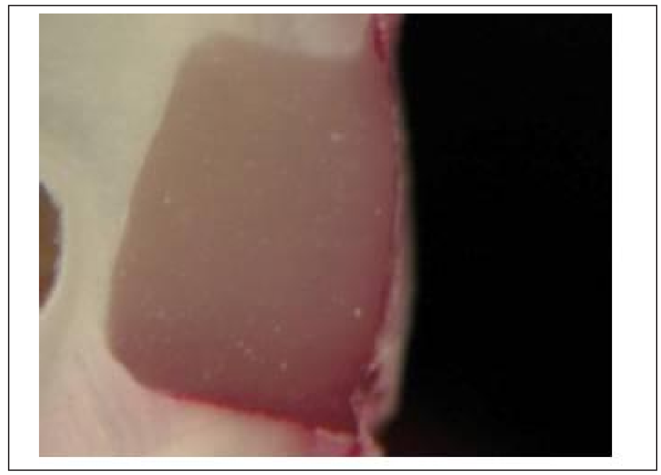

Figure 4. Photograph of the specimens with Score 2. (Group 3)

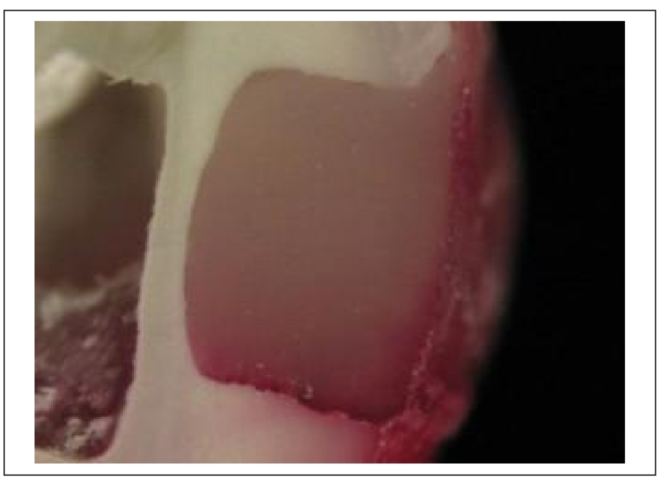

Figure 5. Photograph of the specimens with Score 3. (Group 2)

Early loss of primary teeth can cause a number of problems, including space loss for successor permanent teeth, esthetic, phonetic or functional challenges.[21,22] However, some of the infected primary teeth can be kept in function until exfoliation via endodontic therapy. But endodontic therapy must be the last solution because of its complexity and difficulty for children. If it is possible, survival of the teeth must be provided with early restorative approaches. And, microleakage is the most important problem for the successful restorative approaches.

Many tooth-colored materials, such as high-viscosity glass ionomer cements, resin-modified glass ionomer cements, resin composites, and polyacid-modified resin composites (compomers) are available for the restorations of primary teeth.[23-25] For restorations of permanent teeth, composites offer advantages over compomers and glass ionomers in terms of wear resistance and esthetic stability. However, the requirements may differ for primary teeth, as these have a limited lifespan and their enamel is less wear-resistant than on permanent teeth. In addition, caries rates are likely to be high in children with proximal lesions so that fluoride release may be helpful.[23,24,26,27] Some manufacturers have suggested that compomers can be used without a phosphoric acid pretreatment.[28] Since children may be uncooperative for etching and bonding procedures, compomers may provide a better alternative than resin composites.[29]

To our knowledge, effects of KTP laser on microleakage of compomer restorations on primary teeth has not been yet evaluated. The purpose of this study was to evaluate the effects of pulsed KTP laser on decrease of dentinal microleakage of compomer restorations in primary teeth.

MATERIALS AND METHOD

Twenty-four noncarious, primary first and second molars (time of exfoliation is within three months) were extracted and stored in a saline solution at 4°C, were selected for the study. The teeth were carefully cleaned with a hand scaler and water-pumice slurry

Table 1. Criteria for the microleakage degree [28]

Scores	Contents
0	no dye penetration
1	dye penetration along the interface to one third of the cavity depth
2	dye penetration along the interface to two thirds of the cavity wall depth
3	dye penetration to cavity wall depth but not along the axial wall
4	dye penetration up to and along the axial wall

in dental prophylaxis cups. Class V cavities (n=48), with the occlusal and cervical margins located in the enamel, were prepared on the buccal and lingual surfaces. An inverted diamond bur (KG Sorensen, Zenith Dental ApS, Denmark) at high speed with water spray was used for cavity preparation. Each bur was replaced after five preparations..Cavity dimensions were standardized utilizing a template to trace an outline on both surfaces with a mesiodistal width of 3 mm and an occlusogingival measurement of 2 mm. The depth of the cavity was 1.5 mm, as calibrated by measuring with a marked periodontal probe.

Preparations were performed as uniformly as possible with respect to instrumentation, outline form, size, and depth. The prepared cavities were then thoroughly washed with air/water spray and stored in sterile physiological saline (SPS) at room temprature. The teeth were randomly divided into three groups and 16 cavities were assigned to each group. Group 1 was left without laser treatment as a control. Groups 2 and 3 were irradiated at 1 W, 7.1 J/cm^2 (Ton: 10, Toff: 50, emission mode: repeat), and 1.5 W, 10.7 J/cm^2 (Ton: 10, Toff: 50, emission mode: repeat) with KTP laser energy densities (Smartlite D, Deka, Calenzano Firenze, Italy) for 40 seconds, respectively.

The cavities were restored with a compomer restorative system (Dyract Extra, Dentsply, Konstanz, Germany) according to the manufacturer's instructions. A layer of Prime & Bond adhesive (single-step dentin adhesive, Dentsply, Germany), which was originally recommended for use with this restorative system, was applied to both enamel and dentin for 20 seconds, then the excess of adhesive was removed by gently drying with air from a dental syringe for 5 seconds, followed by light-curing for 10 seconds (Hilux, Benlioğlu Dental, Ankara, Turkey). Dyract Extra restorative material was applied in one increment, and then light-cured for 40 seconds. The curing light's built-in radiometer was used to check for light efficiency before starting each restoration.

After restoration, the specimens were stored in distillated water at 37°C for 24 hr hours. A finishing process was applied using moist Sof-Lex discs (3M Dental Products, St Paul, 55144). Immediately thereafter, the finishing gloss (3M Espe,St Paul, USA) was applied. The specimens were subjected waterbaths with a thermocycling regimen of 500 cycles between 5°C and 55°C. Dwell time was 1 minute, with a 3 seconds transfer time between baths. Next, the samples were dried superficially with absorbent paper and sealed with two coats of nail varnish, leaving a 2 mm window around the cavity restoration margins. The apical region was also sealed with epoxy glue to prevent dye penetration. The specimens were then immersed in 0.5% basic fuchsin solution for 24 hours, and all specimens were rinsed with tap water for 5 minutes and dried with absorbent paper. Each restoration was cut in the buccolingual direction through the center of the restoration with an Isomet slow-speed saw (Beuhler Ltd., Lake Bluff, IL, USA), with a water-cooled diamond disc (Beuhler Diamond Blade, Series 15HC, USA). The degree of dye penetration was scored on the basis of a four-grade scale (Tab. 1, Fig. 1) by two standardized and independent examiners in a blind-manner using a stereomicroscope (Nikon SMZ 800, Tokyo, Japan) at 40X magnification.[30]

The results of the staining measurements were analyzed with the Kruskal-Wallis and Mann-Whitney U tests for independent samples, and the Wilcoxon test for dependent samples. All tests were run at at a significance level of $p<0.05$.

RESULTS

Data showing the extent of leakage scored for occlusal and gingival margins of the restorations and distribution of microleakage scores are shown in Table 2.

When the scores of microleakage at the occlusal margins of the three groups were compared, no statistical differences were found ($p>0.05$) (Tab. 3). However, the lowest mean microleakage values were obtained from Group 3, and the highest values were obtained from Group 1.

When the scores of microleakage at the gingival margins of the three groups were compared, the differences among the groups were found to be statistically significant ($p<0.05$) (Tab. 3). The mean microleakage values of the three groups from lower to higher were Group 3, Group 2, and Group 1. The differences between Group 1 and Group 2 and between Group 1 and Group 3 were found to be statistically significant ($p<0.05$).

Comparing the mean microleakage scores of the occlusal and gingival margins in the each group, statistically significant differences existed in Group 1 and Group 3 ($p<0.05$), and no significant difference existed for Group 2 ($p>0.05$). Using stereomicroscope; scores 0, 1, 2, 3 were shown in the Figure 2-5.

DISCUSSION

The most important factor for long-term clinical success of restorations is to provide an effective and permanent plugging between the restorative material and tooth surfaces. Microgaps may develop between the tooth and filling due to contraction during polymerization of esthetic restorative material in the same color with a

Table 2. Distribution of microleakage scores verified at the occlusal and gingival margins for all groups (n=16)

Groups	*Occlusal scores*					*Gingival scores*				
	0	*1*	*2*	*3*	*4*	*0*	*1*	*2*	*3*	*4*
Group 1	12	4	0	0	0	3	9	4	0	0
Group 2	14	2	0	0	0	9	6	0	1	0
Group 3	15	1	0	0	0	10	5	1	0	0

Table 3. Mean microleakage scores of the occlusal and gingival margins

	Groups	n	Mean	Std. Deviation
Occlusal Margins	Group 1	16	,25	,45
	Group 2	16	,13	,34
	Group 3	16	,06	,25
Gingival Margins	Group 1[a]	16	1,06	,68
	Group 2[b]	16	,56	,81
	Group 3[b]	16	,43	,62

* Values indicated by the distinct letters differ significantly ($p<0.05$).

tooth that is widely and recently used. Bacteria, ions, and fluids may easily pass from these gaps and lead to microleakage, and this condition causes secondary caries, pulp inflammation, sensitivity, and coloring on interfaces.[31]

In the present study, basic fuchsin was used to detect microleakage at the gingival and occlusal surfaces. Different methods have been employed to disclose microleakage around the restorations. Dye leakage is probably the most common method used. The principal advantages of this technique are its low cost and ease of application. Disadvantages include subjective evaluation of results[32] and the low molecular weight of the dye, which is less than that of bacteria. Also, tests using dyes could sometimes detect leakage where bacteria could not penetrate.[33]

Trowbridge[34] stated that locations of cavity walls could affect microleakage. A serious microleakage could develop in restorations, especially if the margins of the cavity are in the cement. The cement-enamel junction has a more permeable structure compared to enamel. This structural distinction leads to more stain penetration in the gingival margin, an outcome emphasized in many previous studies.[33-38] In our study, cavities' occlusal and gingival margins were located in the enamel, which was weak and more permeable in gingival margins than in occlusal margins.

In the present study, the use of pulsed KTP laser energy showed a decrease in microleakage around the restorations. Obeidi *et al* [39] stated that the level of microleakage was significantly less in laser-treated cavities compared to untreated cavities. Also, White *et al* [40] showed similar results. Goodis *et al* [13] stated that a significant decrease was reported to be achieved in the intratubular fluid flow due to closure of tubule orifices following melting after Nd:YAG laser irradiation. Miserendino *et al*.[14] reported that a lower dye permeability of dentin is seen when the prepared dentin surface is treated by Nd:YAG laser energy. Similarly, Siso *et al* [18] expressed that the use of pulsed KTP laser energy showed a decrease in microleakage around the restorations. Araujo *et al*.[41] reported that the application of the Nd:YAG laser following the pretreatment of dentin with non-photocured Single Bond adhesive in cavities prepared with an Er:YAG laser promoted better sealing of the gingival margins. It seems that the deposition of glass-like material seals the dentin walls with partial to total closure of the dentinal tubules. However, Kawaguchi *et al*.[42] stated that the Nd:YAG laser had no influence on marginal microleakage in composite restorations, independent of the moment the laser was used. Since very few reports on the KTP laser have been published, in this study the KTP laser was compared with the Nd:YAG laser.

Martinez-Insua *et al* [43] and Corpas-Paster *et al* [44] reported that the Er:YAG and Nd:YAG laser pretreatment for bonding is unfavorable to adhesion, and that the mean tensile bond for laser-etch enamel and dentin was significantly lower than for acid-etched. So the additional use of etching after laser preparation is recommended.[45] However, some manufacturers have suggested that compomers can be used without a phosphoric acid pretreatment.[28] So in the present study, we prefered compomer restorations in primary teeth.

CONCLUSION

The findings of the current study indicated that the pulsed KTP laser (with power of 1.5W, 10.7 J/cm2) sealed dentinal tubules and consequently reduced microleakage towards pulp in primary teeth. We concluded that KTP laser could be used for decrease of dentinal microleakage of compomer restorations in primary teeth and early loss of primary teeth can be prevented.

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