In vitro and in vivo studies on application of erbium: YAG laser for dentine hypersensitivity

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Abstract

This study was performed to examine the possibility of Er:YAG laser for dentine hypersensitivity treatment using a novel laser probe; broom-type probe. The morphological change of dentinal tubules of bovine dentine plate after low power laser irradiation (5 or 10 mJ/pulse, 10 pps) or boiling was observed by SEM. Fifty teeth from 13 patients aged 31–54 years with complaint of dentine hypersensitivity were treated by laser irradiation at 25–35 mJ/pulse, 10 pps using the broom-type probe.

Clinical effect of laser irradiation was verified by the examination of sensitivity rate to cold water, air blow and mechanical stimuli of explorer before, immediately after and 1, 3, 5 and 12 weeks after laser irradiation. The ratio of blockade and reduction of dentinal tubules after laser irradiation was 16–61%. Owing to vaporization of water in dentinal tubules after laser irradiation was described by SEM. Remarkable clinical improvement of dentine hypersensitivity by laser was obtained but recurrence was also partially detected. The present study suggests low power irradiation of Er:YAG laser would be effective on the treatment of dentine hypersensitivity, but a partial limitation of the effect of laser treatment for dentine hypersensitivity may exist.

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1. Background

Er:YAG laser is promising in the dental field due to its characteristic of high absorbability in water [1]. Dentine hypersensitivity is defined as short, sharp pain arising from exposed dentine in response to various stimuli that cannot be explained by any other form of dental defect or pathology [2]. There are several theories concerning the mechanisms of pain elicited from the dentine: Nerve innervation theory, Odontoblast theory, Mechanoreceptive complex theory and Hydrodynamic theory. Among these, hydrodynamic theory is supported by the majority. Matthews and Vongsavan [3] demonstrated that tubular fluid flow, generated by hydrostatic pressure stimuli, was correlated with intradental nerve discharge. Various treatment modalities for dentine hypersensitivity have been known so far, but these are good for neither one thing nor the other. The objective of this study was to evaluate the effect of low power irradiation of Er:YAG laser using a broom-type probe [4] on dentine hypersensitivity in vivo and in vitro.

2. Methods

Laser apparatus used in this experiments was Er:YAG laser prototype (MEY-1™ manufactured by J. Morita Mfg., Kyoto, Japan). Its transmission was hollow wave guide. The novel broom-type probe was made of 19 super-fine optical fibers bound into a broom shape. The size for a probe was: core diameter, 135 \( \mu \)m; cladding diameter, 150 \( \mu \)m; and jacket diameter, 200 \( \mu \)m.

Using cross-sectioned specimens of bovine dentine plate, the ratio of blockade of dentinal tubules and reduction ratio of its diameter were calculated after laser irradiation at 5 or 10 mJ/ pulse, 10 pps with speed rate of 50 or 100 mm/min. Non-irradiated area was regarded as control. The morphological change of dentinal tubules after laser irradiation and boiling was observed by scanning electron microscopy (SEM). Surface temperature of samples during laser irradiation was analyzed by thermograph.

Fifty teeth from 13 patients (5 males, 8 females) aged 31–54 years with complaint of dentine hypersensitivity were treated by laser irradiation at 25–35 mJ/pulse (equivalent to 10–15 mJ/ pulse at the end of probe), 10 pps without water using the novel broom-type probe. Informed consent was obtained from volunteers before clinical trial. Clinical effect of laser irradiation was verified by the examination of sensitivity rate to cold water, air blow and tactile stimuli before, immediately after and 1, 3, 5 and 12 weeks after laser irradiation. Dummy laser device was used in the placebo group and the same examination was carried out.

3. Results

The ratio of blockade of dentinal tubules and reduction of its diameter after laser irradiation was 16–61% compared to the control. Surface temperature of dentine plate during laser irradiation was around 100 °C. The accumulation of organic elements or...
insoluble salts was observed by SEM at the site of blockade and reduction of dentinal tubules. These deposits appeared to be due to the result of sudden vaporization of fluid in dentinal tubules and degeneration or coagulation of organic elements of its wall.

Remarkable clinical improvement of dentine hypersensitivity by laser was achieved but recurrence was also partially detected.

4. Conclusions

The present study suggested that low power irradiation of Er:YAG laser would be effective for dentine hypersensitivity but a partial limitation might exist. Further study is required to establish the most effective laser treatment for dentine hypersensitivity.

References