In 1987, Dr. John Featherstone described demineralization as the precursor to dental caries.1 When sufficient mineral has been removed from the enamel, the structure collapses, causing cavity formation (dental caries) that can be seen visually or by radiograph. Therefore, prevention of demineralization can reduce or prevent dental caries (tooth decay).

Studies have recorded the reduction of caries-like lesions or demineralization of extracted human teeth that were irradiated with CO2 laser energy. In 1972, Stern et al described reduction of subsurface lesions.2 Featherstone and Nelson reported that CO2 laser of the appropriate wavelength reduced demineralization in enamel.3 Fox et al showed a slowing of enamel initial dissolution rates following CO2 laser exposure.4 Studies using the Nd:YAG laser in conjunction with a surface initiator reported a reduction in subsurface lesions or increased resistance to acid attack.5, 6 The argon laser has also been reported effective in reducing the loss of tooth structure or depth of subsurface lesions.7, 8 Fried et al demonstrated the effectiveness of both the Er:YAG and Er:YSGG in caries inhibition.9

As effective as laser irradiation is on reducing caries-like lesions or preventing demineralization, experiments have shown that the addition of chemical inhibitors or fluoride increases the effectiveness of either the laser irradiation or the fluoride alone. Fox et al demonstrated the ability of chemical inhibitors combined with CO2 laser irradiation to reduce the dissolution of dental enamel.10 Featherstone and his group showed similar effects of the reduction of mineral loss in enamel fissures following CO2 laser irradiation plus APF fluoride.11 Similar effects were demonstrated with low level argon laser irradiation and fluoride.12-14

As impressively as in vitro and laboratory studies have shown the effectiveness of laser irradiation in reducing or preventing dental caries in extracted teeth, the real test of effectiveness is in vivo. A number of in vivo clinical studies have demonstrated similar effectiveness to the in vitro studies, either with the laser alone or in a combination of laser plus fluoride. Blankenau demonstrated clinically, through the use of an Ogaard model, the effectiveness of the argon laser alone in reducing the size and depth of caries-like lesions. He showed a 29% decrease in the depth of the lesions of all teeth involved in the experiment.15 Anderson et al later confirmed these results in experiments. In fact, they demonstrated that 75% of lased teeth developed no lesions at all.16 During the same time period, Featherstone and his group, using an intraoral model,
showed the effectiveness of the CO2 laser to inhibit further demineralization of preformed caries. Likewise, clinical studies have demonstrated the effectiveness of other lasers plus fluoride on reducing dental caries. In a clinical study in 2001, Zezell and Edwards reported the effectiveness of the Nd:YAG laser plus fluoride in reducing dental caries by 68%, or 2.5 times fewer carious lesions than the nonlased teeth. Harazaki and his group also showed the effectiveness of the Nd:YAG laser plus fluoride on the prevention and reduction of white-spot lesions associated orthodontic bands. A clinical study reported by Hicks et al leaves little doubt about the effectiveness of the argon laser and fluoride combination on the reduction of caries formation. Each tooth that was treated, either by laser or by laser plus fluoride, showed a significant reduction in lesion size. The combination of laser plus fluoride reduced the lesion depth by an average of 62%.

Further experiments have confirmed the effectiveness of lasers in decay and dental caries prevention. In a well-documented clinical study, Nammour et al showed the ability of an argon laser to increase the retention of fluoride in enamel, even over a six month period. It appears that lasers have an effective role in the prevention of the decay process. Even when a laser (argon) is used with commercial remineralizing solution, the effectiveness in the prevention process is increased because of the laser. This was demonstrated in a recent article by Westerman et al that reported a 62% reduction in lesion depth. The new diode laser at 810-nm wavelength has demonstrated effects similar to that of the argon, CO2, and Er:YAG lasers in reducing enamel caries formation in vitro.

The effectiveness of lasers in the prevention or reduction of dental caries seems to be related to the properties of the laser and not to that of wavelength per se. This was demonstrated by a comparison of halogen curing light or light-emitting diode to a laser (argon) and the ineffectiveness of these nonlaser light sources in preventing or reducing caries-like lesions.

Published scientific evidence over many years leaves little doubt as to the effectiveness of the laser in reducing or preventing dental caries. The combination of laser plus fluoride in the reduction of, or prevention of, dental caries appears even more effective, and these clinical trials have confirmed the results of the in vitro studies. The safety of these procedures has been demonstrated experimentally, as well as through clinical use. Although a variety of lasers have shown effectiveness for this clinical application, the greatest amount of published data and clinical trials have been related to the argon laser. For over 15 years, the argon laser has been used safely on teeth with similar or identical parameters.

The evidence to date substantially supports the effectiveness and safety of the laser plus fluoride combination in reducing or preventing clinical dental caries.

REFERENCES

17. Featherstone JDB. Intra-oral model – CO₂ pre-formed caries-like lesion. SPIE 2001, San Jose, California, USA.

Contact address: Professor G. Lynn Powell, DDS; Dept. of Dental Education, University of Utah, Salt Lake City, Utah 84132, USA. Fax: +1 (801) 585-6485. e-mail: DentalEd@hsc.utah.edu