The Evolution of Lasers in Dentistry

Ruby to YSGG

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An amazing paradigm-shift

is occurring in dentistry with a technology breakthrough that gives dentists the capability to perform a wide range of hard-and-soft tissue procedures with improved patient outcomes, less trauma, reduced post-op complications — and in most cases, with no need for injections. This new technology greatly expands the scope of procedures a dentist can offer their patients.

Dentists are now successfully integrating the Er,Cr: YSGG laser technology (Waterlase® MD laser, BIOLASE Technology, Inc.) into their practices with the broadest indications for use of any other laser in medicine or dentistry. Lasers have been used in almost every other medical field, but they are typically a single-wavelength laser the clinician purchased for a specific application. For example, an opthalmologist must purchase an excimer laser for refractive surgery, argon for retinal surgery, and a Q-switch Nd:YAG for capsulotomies. A dermotologist may purchase a Q-switched Ruby for tattoo removal, diode for hair removal, and an Er:YAG for skin resurfacing. Even with the need for multiple lasers, medical professionals recognize the lasers *still* provide excellent return on investment and superior clinical results for new, unique procedures specific to lasers.

Fortunately, for dentists, a single laser wavelength as emerged that allows them to practice dentistry across all oral tissue. While lasers have been involved in dentistry for more than 20 years, until recently, no single laser had been cleared for and is capable for use on *all oral tissues*, including hard tissue, soft tissue, endo, perio, and bone. That all changed with the introduction of the YSGG laser. This laser was the first to obtain marketing clearances for use on all oral tissues, and it has emerged as the pinnacle of the dental laser revolution. Dentists now have access to a single instrument that can be utilized in all areas of their clinical practice, and provide new opportunities for

Fig. 1. FDA-cleared Indications for use for the YSGG laser.

Hard Tissue	• Class I, II, III, IV and V cavity preparation • Caries removal • Hard tissue surface roughening and etching • Enameloplasty, excavation of pits and fissures for placement of sealants
Root Canal	• Tooth preparation to obtain access to a root canal • Root canal preparation including enlargement • Root canal debridement and cleaning • Pulpotomy as an adjunct to root canal therapy
Endo Surgery	• Flap preparation – incision of soft tissue to prepare a flap and expose the bone • Cutting bone to prepare a window access to the apex (apices) of the root(s) • Apicoectomy – amputation of the root end • Root end preparation for retrofill amalgam or composite • Removal of pathological tissues (i.e., cysts, neoplasm or abscess) and hyperplastic tissues (i.e., granulation tissue) from around the apex. (NOTE: Any tissue growth (i.e., cyst, neoplasm or other lesions) must be submitted to a qualified laboratory for histopathological evaluation)
Bone	• Cutting, shaving, contouring and resection of oral osseous tissues • Osteoplasty and osseous recontouring (removal of bone to correct osseous defects and create physiologic osseous contours) • Ostectomy (resection of bone to restore bony architecture, resection of bone for grafting, etc.) • Osseous crown lengthening
Soft Tissue	• Incision, excision, vaporization, ablation and coagulation of oral soft tissues, including: excisional and incisional biopsies • Exposure of unerupted teeth • Fibroma removal • Flap preparation – incision of soft tissue to prepare a flap and expose the bone • Frenectomy and frenotomy • Gingival troughing for crown impressions • Gingival troughing for crown impressions • Gingivectomy or gingivoplasty • Gingival incision and excision • Hemostasis • Implant recovery • Incision and drainage of abscesses • Leukoplakia • Operculectomy • Oral papillectomies • Pulpotomy • Pulp extirpation • Reduction of gingival hypertrophy • Soft tissue crown lengthening • Treatment of canker sores, herpetic and aphthous ulcers of the oral mucosa • Vestibuloplasty
Perio	• Sulcular debridement (removal of diseased or inflamed soft tissue in the periodontal pocket to improve clinical indices including gingival index, gingival bleeding index, probe depth, attachment loss and tooth mobility) • Flap preparation -- incision of soft tissue to prepare a flap and expose unerupted teeth (hard and soft tissue impactions) • Full thickness flap • Partial thickness flap • Split thickness flap • Removal of granulation tissue from bony defects • Laser soft tissue curettage of the post-extraction tooth sockets and the periapical area during apical surgery

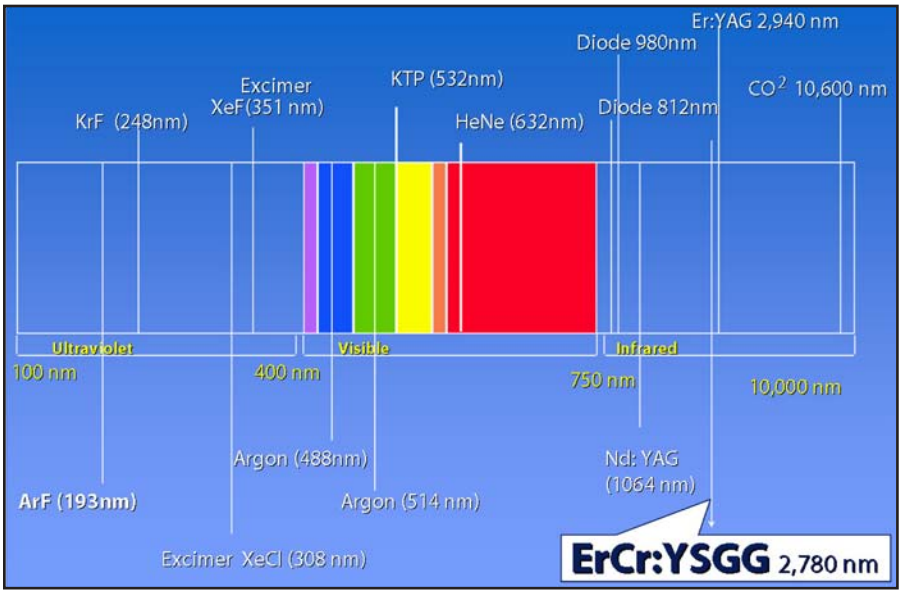

Fig. 2. Electromagnetic Spectrum. Lasers have certain properties based on their position in the electromagnetic wave spectrum. The YSGG laser emits a wavelength of 2,780 nanometers, in the mid-infrared spectrum.

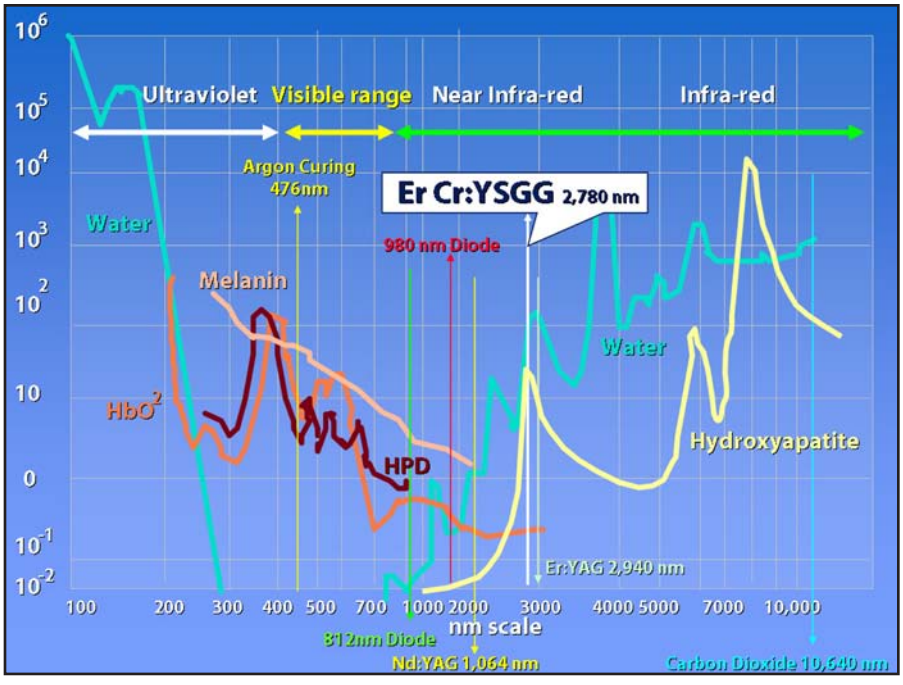

Fig. 3. Absorption Coefficient Table. The YSGG laser is near the peak absorption in water, which allows it to effectively cut enamel, dentin, hydroxyapatite and bone. Despite their proximity on the scale, the Er,Cr:YSGG and Er:YAG are separated by more than 300% on the scale.

increased ROI and improved patient care. According to Deidrich and Bushick in the February 2004 edition of the *Journal of the American Dental Association*, the advent of the YSGG laser is the "most important recent development in laser dentistry."

The present report addresses a brief history of dental lasers, and the evolution of these systems from the first ruby laser to the YSGG laser. This report also addresses the wide array of clinical applications (Fig. 1) using the YSGG laser, including hard tissue, soft tissue, endo, perio, and bone, as well as new applications that continue to shape an emerging standard of preventive and minimally invasive care in dentistry.

Although lasers have not yet replaced conventional instrumentation in all applications, this report of the clinical uses of the YSGG laser clearly demonstrates that no other instrument in dentistry has the versatility and clinical utility of this device.

Terminology and Concepts in Laser Dentistry

Before exploring the evolution of dental lasers, it is important to understand several terms and concepts when discussing laser dentistry. Lasers are usually named for the "active medium" that is charged with energy inside the laser unit to create laser light. For example, the YSGG laser receives its name from the elements that compose the crystal medium inside the laser system – yttrium, scandium, gallium and garnet, doped with erbium and chromium (Er,Cr:YSGG). When the crystal is pumped with energy, a specific, monochromatic wavelength of light is emitted from the crystal and transferred to the target tissue through a delivery system. In the case of the YSGG laser, the wavelength delivered from the laser through a fiber optic cable is 2,780 nanometers. Other lasers, such as the Nd:YAG lasers operate at 1,064 nanometers, CO_2 lasers at 10,600 nanometers, Erbium:YAG at 2,940 nanometers, and so on (Fig. 2 – Electromagnetic Spectrum).

Another key concept is that different laser wavelengths react with tissue in different ways. Depending on their "absorption

coefficient," laser light has properties that cause it to interact and absorb differently with target tissue. For example, the laser light from a diode laser is most effectively absorbed in pigmented tissues and melanin, which makes it an ideal tool for use in cutting and coagulating soft tissue. The YSGG laser is well absorbed in water and hydroxyapatite (Fig. 3 - Absorption Coefficient Table), which makes it an excellent tool for cutting enamel, dentin, bone, and soft tissue.

A Brief History of Lasers

The first laser was developed by Theodore H. Maiman. Using a theory originally postulated by Einstein, Maiman created a device where a crystal medium was stimulated by energy, and radiant, laser light was emitted from the crystal. This first laser was a Ruby laser. One year later, Snitzer released the neodymium laser (Nd: YAG). All of the early dental research focused on the Ruby laser, and the Nd: YAG laser was largely ignored during the early years. Experiments by Stern and Sognnaes found that the Ruby laser was not an effective wavelength for cutting enamel and dentin. Additional work by Stern suggested a possible role for lasers in caries prevention, but overall, hard tissue applications for the Ruby laser were not promising.

Research then focused on soft tissue, where several of the early lasers proved to be successful. The argon, carbon dioxide, and Nd:YAG laser proved effective for cutting and coagulating soft tissue. The first reported oral surgical application using a $C0_2$ laser occurred in 1977 (Lenz, et al, 1977). Because of the thermal nature of these soft-tissue lasers, injections were required in most cases. In January 1987, the first FDA clearance for a $C0_2$ laser used in oral surgery paved the way for the acceptance and viability of using lasers in the oral cavity in a clinical environment. The stage was set for a new round of research and investigations into lasers for broader applications such as cutting enamel, dentin, and bone.

The Dental Laser Revolution Begins

The search for a laser system with broader applications in dentistry led Dr. Terry Meyers and his brother William, an ophthalmologist, to select the Nd: YAG laser for experiments on the removal of incipient caries (Meyers, Meyers, 1985). Soon after, they began developing the first true dental laser system, which according to textbooks and published literature, sparked the dental laser revolution. Their product, the D-Lase 300, led to the founding of American Dental Laser (acquired by BIOLASE Technology, Inc. in 2003), the creation of several dental laser associations, and the first widespread exposure of lasers to dentistry. In May 1991, the FDA granted a marketing clearance to American Dental Laser for soft tissue uses. Awareness was surging forward, and there were several major research projects underway using newer wavelengths in the experimental cutting of enamel and dentin.

Evolving Technology

Following American Dental Laser, a number of other companies, including Luxar, HGM, Excel and BIOLASE offered Nd:YAG, CO_2, and argon lasers for use

Figure 4. The YSGG laser uses a patented combination of laser energy, water, and air to ablate enamel, dentin, bone, and soft tissue.

Figure 5. The YSGG laser is cleared for cavity preps Class I-V (Class I pictured) as well as caries removal, enameloplasty, and pits and fissures. (Case courtesy of Dr. James Jesse.)

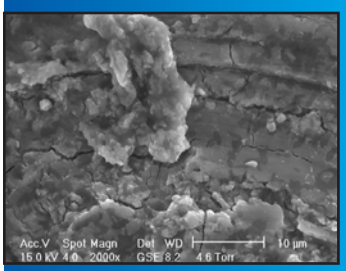

Figure 6a. The high-speed drill leaves a smear layer of debris on the surface of the treated tooth (5000x magnification, photo courtesy of Loma Linda University.)

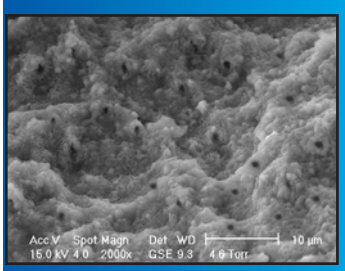

Figure 6b. After treatment with the YSGG laser, there is no smear layer and the dentinal tubules are open, which improves bonding. (5000x magnification, photo courtesy of Loma Linda University).

Fig. 7. A lingual frenectomy completed with the YSGG laser (Case courtesy of Dr. James Jesse, Colton, Calif.)

Fig. 8. The YSGG laser is also effective for trimming gingival tissue with smooth contours and very little bleeding. (Case courtesy of Dr. James Jesse.)

Figure 8. While most dentists refer conditions such as fibroma to an oral surgeon, the YSGG laser allows quick, bloodless removal of lesions for biopsy.

Figure 9. The YSGG laser was the first cleared for all stages of endo therapy, including accessing the canal, pulpotomy (pictured), and cleaning, shaping and debriding the canal.

in soft tissue. In 1988 in Europe and 1989 in the United States, BIOLASE filed patents for the novel use of lasers with water in dentistry. The company began development of a laser device exclusively for this purpose.

In May 1997, Premier Laser obtained the first marketing clearance from the U.S. FDA to cut enamel and dentin in adults using an Er:YAG laser, a device readily available in dermatology and plastic surgery. Later, other companies, including OpusDent, Hoya ConBio, Kavo, Deka and Fotona adapted the Er:YAG technology as well, making additional strides for laser use in dentistry.

In 1998, after more than ten years of research and investigation, BIOLASE obtained a marketing clearance for cutting hard tissue in adults using an all-new laser designed by the company *exclusively* for use in dentistry.

This dentistry-only laser, known as the YSGG laser, was called the "Millennium" and it used a patented combination of YSGG laser energy, water and air to safely and effectively ablate enamel and dentin in adults. The YSGG laser was then cleared for use on patients of all ages, and the company began selling the laser worldwide.

Researchers began working on soft tissue with the YSGG laser. With the water spray minimized or turned off, the laser could effectively cut and coagulate soft tissue with more control, and in many cases, much faster. By 2000, greatly expanded FDA clearances for soft tissue indications had been obtained by BIOLASE, and clinicians were able to work on all oral tissues.

BIOLASE released a second YSGG laser, the "Waterlase," in 2000, and the Waterlase MD in 2004 (Fig. 4), which included many new features never before used in laser dentistry. The company also obtained a series of ground-breaking clearances from the FDA for complete laser endodontics (2002), apicoectomy (2002), cutting and shaving oral osseous tissues (2003), as well as the most complete list of procedures related to periodontal therapy, including laser curettage and osseous crown lengthening (2004). Other laser companies have managed to obtain a few of these same clearances later.

Research continues for future indications with an all-tissue laser, including crown and veneer preparations, orthodontic applications, advanced new implant therapies including sinus augmentation and bone grafting, gingival tissue resurfacing, and even low-level laser therapy applications using the YSGG laser.

Clinical Applications and Descriptions

Because of its broad versatility, Deidrich and Bushick reported in the February 2004 issue of the *Journal of the American Dental Association* that the YSGG laser finally "makes the economics of providing laser therapy more feasible." For this report, the clinical applications of the YSGG laser will be reviewed in finer detail in essentially the same order in which the indications were cleared by the U.S. FDA.

Cutting Hard Tissue (Enamel and Dentin)

The YSGG laser was cleared for Class I, II, III, IV, and V cavity preps, as

well as caries removal in adults (Fig. 5) in 1999, with a similar clearance for children soon thereafter (1999). Since then, published reports have demonstrated the laser's ability to reduce and even eliminate the smear layer associated with traditional rotary instruments (Fig. 6a and Fig. 6b), which can improve surface adhesion and bond strength for restorations (Gutknecht, Apel, et. al, 2001). Also, because the laser reacts at a cellular level and helps to prohibit the pain response (Tuner and Hodes, 2002), most hard tissue procedures can be completed without the aid of injected anesthetic. The YSGG laser also allows the precise treatment of pits and fissures on the occlusal surfaces of molars, which has aided in the growing discipline of "micro" and "minimally invasive" dentistry (Rosenberg 2003).

Soft Tissue

Soon after obtaining the first hard-tissue clearances for the YSGG laser, BIOLASE obtained a collection of clearances related to soft tissue (July 2001), including sulcular debridement. The YSGG laser demonstrated the capability to atraumatically treat soft tissue with little to no bleeding, little edema, and positive post-operative results. The YSGG laser was the first hard-tissue laser cleared for soft tissue indications such as treatment of aphthous ulcers, herpetic lesions, and leukoplakia. In addition, the laser was cleared for oral surgical applications such as frenectomy (Fig. 7), gingivectomy (Fig. 8), fibroma removal (Fig. 9), and bloodless troughing around a prep prior to taking an impression.

Root Canal

With hard tissue and soft tissue procedures cleared by the FDA, research and development turned to other disciplines where lasers had already showed some potential for disinfection, sterilization, and other benefits. The YSGG laser was the first laser cleared for root canal, including tooth preparation to obtain access to the canal, root preparation, and canal enlargement and cleaning (Fig. 10). The same benefits that are evident when cutting enamel and dentin were also available when the YSGG laser was used in the canal. The smear layer was eleiminated and debris were dramatically reduced, and the dentinal tubules remained free and clear, which may aid in improved obturation and sealing of the canal (Fig. 11, 12, 13).

Bone Surgery and Osseous Crown Lengthening

The YSGG laser was also the first cleared for bone, including cutting, shaving, contouring and resecting oral osseous tissues (February 2002). The laser was later cleared for osteoplasty, ostectomy, and osseous recontouring to correct defects and create physiologic osseous contours necessary for ideal clinical results. In 2003, the YSGG laser was the first laser device cleared for osseous crown lengthening to achieve biologic width (Fig. 14), which can be completed without laying a flap, suturing, or damage to the bone (Wang, 2002). The ease of use of the YSGG system provides the dentist with a strong ROI by performing most of their own osseous crown lengthening procedures, which is important in an era fueled by prime time "extreme" dental makeovers, and growing demand for aesthetic dentistry.

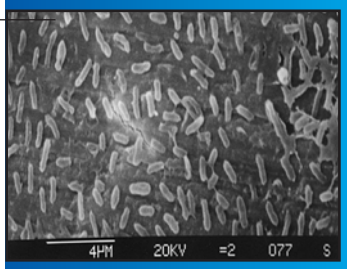

Figure 11. The coronal third of a root canal after treatment with the Profile rotary system. (5000x mag). (Photo courtesy of Loma Linda University).

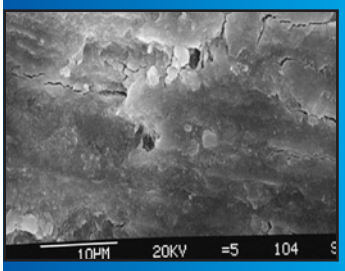

Figure 12. The coronal third of a root canal after treatment with manual K files (5000x mag). (Photo courtesy of Loma Linda University.)

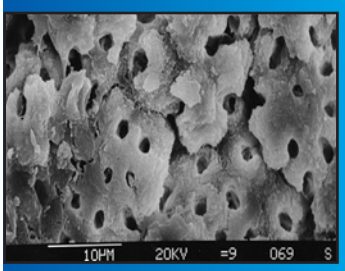

Figure 13. The coronal third of a canal treated with the YSGG laser. Note the absence of smear layer in the canal (5000x mag). (Photo courtesy of Loma Linda University.)

Figure 14. The YSGG laser can be used for closed flap crown lengthening, where the laser uses low amounts of energy to shave and contour osseous tissue to achieve biologic width. (Case courtesy of Dr. David Eshom, La Jolla, California.)

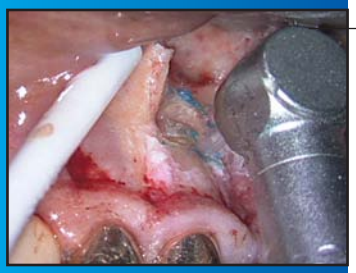

Figure 15. The YSGG laser is cleared to perform apicoectomy, including flap elevation, accessing the diseased apex, and excising the infected tissue. (Case courtesy of Dr. David Browdy, Long Island, New York.)

Figure 16. The YSGG laser can be used for laser curettage and sulcular debridement, as part of a complete laser periodontal program. (Case courtesy of Dr. Michael Koceja, Portland, Oregon.)

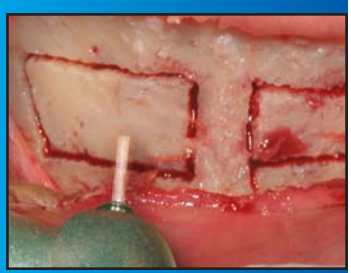

Figure 17. The YSGG laser is used in procedures involving the harvesting and grafting of bone tissue. (Case courtesy of Dr. David Rhoden, Waco, Texas.)

Fig. 18. The YSGG laser is even being used for crown and veneer preparations. (Case courtesy of Dr. Mark Colonna, Whitefish, Montana.)

Apicoectomy & Endodontic Surgery

Other advanced endodontic applications include the YSGG's ground-breaking clearance for apicoectomy (2003), which, for the first time, allowed a clinician to use a single instrument for all major steps of an apicoectomy procedure, including flap preparation, cutting bone, amputating the root tip, removing pathological tissue and hyperplastic tissue from around the site, and preparing the site for retrofill amalgam or composite (Fig. 15).

Periodontal Procedures

The YSGG laser is the first and only laser cleared for the major indications in laser periodontal therapy. While other lasers such as the diode laser and Nd:YAG laser are cleared for soft tissue applications related to perio, none have been cleared for cutting oral osseous tissues, a core component of any periodontal program. The YSGG laser was recently cleared by the FDA for a wide array of indications related to periodontal health, including laser curettage, sulcular debridement (Fig. 16), ostectomy, osteotomy (Fig. 17), soft tissue flap elevation, removal of pathological tissues from bony sockets, and many other important clinical applications.

Innovations and Future Applications

Researchers continue to explore new applications for the YSGG Laser. For example, Dr. Mark Colonna published the first-ever laser-only crown preps in late 2002 (Fig. 18), and research continues with BIOLASE to perfect the technique. In regard to implant therapy and applications, one of the first YSGG laser users in the world, Dr. Robert Miller, has created ground-breaking techniques to treat failing and ailing implants (Miller 2002), and Dr. Norberto Berna of Italy created the first system for placing implants in a single visit (Berna 2003). Dr. Berna's research has spawned hybrid techniques that have appeared in the U.S. Dr. Sascha Jovanovic, a renowned lecturer and researcher from UCLA, completed the first sinus augmentation using the YSGG laser in North America in early 2003. In regard to low-level laser therapy and "soft" laser applications, Drs. Arun and Rita Darbar of England, and Dr. Jon Karna of California have led the way in the research for "soft" laser therapy and photobiomodulation. Finally, Professor Paul Bradley of Nova Southeastern University is currently studying the analgesic and anesthetic effects of the YSGG laser.

Benefits of the YSGG Laser to the Patient and Practice

The benefits of a versatile instrument such as the YSGG laser are clearly evident. The fact that a single instrument has been cleared for hard tissue, soft tissue, and bone, as well as correlating therapies for root canal, oral surgery, and perio, makes it applicable to nearly every aspect of practicing dentistry.

The dramatic reduction of pain in most cases reduces the need for injected anesthesia and frees up chair time for a busy practice (Shulkin, 1991), and can generate increased word-of-mouth referrals among your patients. According to various reports, 100 million patients fear a visit to the dentist because of fear of the drill and the needle. The ADA recently reported that at least 82% of patients think it "somewhat important, important, or very important," that a

dental office have a dental laser, which allows a practice to offer a different type of dentistry.

The laser dramatically reduces the need to apply a high-speed drill to the tooth surface for any reason; however, it has yet to completely replace the drill because a laser cannot effectively cut reflective surfaces such as metal and porcelain. Still, the fact that a single instrument can remove bulk amounts of enamel, dentin and decay, then cut soft tissue around the site, return to removing enamel, and then etch the surface in the time it typically takes for anesthetic to take effect – it hearkens to an exciting new era of efficient, minimally invasive laser dentistry.

Lasers can no longer be considered a niche tool for only the most cutting-edge dentists. The YSGG laser has practical, viable applications across a wide clinical spectrum: hard tissue, soft tissue, bone, endo and perio.

Summary and Conclusions

A laser dentist was recently overheard at a trade meeting speaking to a skeptical colleague about laser dentistry. He said, "the genie is out of the bottle, and it's not going back anytime soon." Backed by more than 25 years of research, development and investigation by countless clinicians and companies, laser dentistry is entering a new era of legitimacy, fueled by the versatility and broad utility of the YSGG laser.

To learn more about the YSGG laser and lasers in general, there are seminars and symposiums available through the World Clinical Laser Institute, as well as educational tools and DVDs available through dentists using the YSGG laser.

The pinnacle of the research and investigation has resulted in the YSGG laser, which offers the broadest capabilities across all disciplines in dentistry. Today's dentist has an opportunity to integrate YSGG laser technology, which can enable him or her to perform dentistry with better clinical results, more patient comfort, and faster recovery.

YSGG laser technology can greatly expand the ability of a dentist to address the clinical needs of the patient, and do more procedures both clinically and cosmetically.

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1. Lasers have been used in the dental professional for more than how many years?
   a. 5
   b. 10
   c. 15
   d. 20

2. True or False. There is a laser that may be used across all types of tissue, including enamel, dentin, soft tissue, and bone.
   a. True
   b. False

3. Which wavelength is able to work across all oral tissue types?
   a. Diode
   b. C02
   c. Er,Cr:YSGG
   d. None of the above

4. How are lasers typically named or classified?
   a. Named after the medium that is charged with energy to create a specific type of laser light
   b. Named after the company that markets the laser.
   c. Named after their inventor.
   d. Named after the university that conducts the pre-market research.

5. How does the YSGG laser operate?
   a. Specific, pulsed amounts of energy are pumped into a crystal and transferred to the tissue through a fiber-optic delivery system.
   b. A semiconductor emits pulsed energy that transforms itself into laser light.
   c. Gas is compressed in a chamber and released as energy.
   d. None of the above.

6. True or False. Diode lasers are excellent tools for use in cutting and coagulating soft tissue.
   a. True.
   b. False.

7. What was the name of the first laser researched for dental laser applications?
   a. Emerald laser
   b. Diamond laser
   c. Ruby laser
   d. Platinum laser

8. Was the first laser successful in trials for cutting hard tissue?
   a. Yes
   b. No

9. What year did Lenz perform the first recorded oral surgery procedure with a laser in a clinical environment?
   a. 1997
   b. 1987
   c. 1977
   d. 1967

10. Was anesthetic generally required when using early lasers for soft tissue applications?
   a. Yes
   b. No

11. What year did the FDA first clear lasers for use in the oral cavity?
   a. 1997
   b. 1987
   c. 1977
   d. 1967

12. Dr. Terry Meyers founded what laser company?
   a. Premier
   b. American Dental Laser
   c. Coherent, Inc.
   d. Cynosure, Inc.

13. In 1997, what company obtained the first marketing clearance for cutting enamel and dentin in adults?
   a. BIOLASE
   b. American Dental Laser
   c. Premier Laser
   d. Ivoclar

14. What was the name of the first YSGG laser cleared for cutting hard tissue in adults?
   a. Millennium
   b. Centurion
   c. Spartan
   d. Maxlite

15. What year was the Waterlase second-generation YSGG laser released?
   a. 1998
   b. 1999
   c. 2000
   d. 2001

16. The YSGG laser has FDA marketing clearances for which procedures?
   a. Root canals
   b. Osseous crown lengthening
   c. Laser curettage
   d. All of the above

17. The statement that the YSGG laser finally "makes the economics of providing laser therapy more feasible" was published in which medical/dental journal?
    a. Lasers in Surgery and Medicine
    b. Journal of the American Dental Association
    c. Journal of Endodontics
    d. Dental Products Report

18. The YSGG laser is approved for what types of cavity preps?
    a. Class I-V
    b. Class I and V only
    c. Class II, III and IV only
    d. None of the above

19. What year was the YSGG laser approved for cavity preps in children?
    a. 1999
    b. 1998
    c. 1997
    d. none of the above

20. Is the YSGG laser able to reduce or eliminate the smear layer associated with traditional rotary instruments?
    a. Yes
    b. No

21. How often can hard tissue procedures be completed with the YSGG laser without the need for injected anesthestic?
    a. Never
    b. Very Rarely
    c. Rarely
    d. Most of the time

22. What are some advantages for using the YSGG laser for soft tissue procedures?
    a. Little to no bleeding
    b. Little swelling and minimal post-operative complications
    c. a & b
    d. None of the above

23. What are some of the advantages of using a laser to shape and debride a root canal?
    a. Smear layer and debris are minimized in the canal
    b. Dentinal tubules remain free and open
    c. a & b

24. What soft tissue procedures has the YSGG been cleared for?
    a. Treatment of aphthous ulcers
    b. Treatment of herpetic lesions
    c. Leukoplakia
    d. All of the above

25. What oral surgical procedures has the YSGG been cleared for?
    a. Frenectomy
    b. Implant uncovery
    c. Fibroma removal
    d. All of the above

26. Can the YSGG laser be used to amputate an infected root tip during an apicoectomy procedure?
    a. Yes
    b. No

27. The YSGG laser was recently cleared by the FDA for which perio procedures?
    a. Laser curettage
    b. Sulcular debridement
    c. Removal of pathological tissues from a bony socket
    d. All of the above

28. What YSGG laser dentist published the first-ever laser crown preps in late 2002?
    a. Dr. William Chen
    b. Dr. Mark Colonna
    c. Dr. Howard Farran
    d. Dr. Sascha Jovanovic

29. True or false. Lasers cannot cut reflective material such as amalgam or porcelain.
    a. True
    b. False

30. The ADA published a survey that reported what percentage of patients think it at least "somewhat important, important, or very important" that a dental practice own a dental laser?
    a. 12%
    b. 32%
    c. 52%
    d. 82%

ANSWER SHEET

The Evolution of Lasers in Dentistry

This course is intended for dentists, dental hygienists, and dental assistants.

Name

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After reading instructions: 1) Complete all information above. 2) Complete answer sheets with either a pen or a pencil. 3) Mark only one answer for each question. 4) When test is completed, enclose the completed answer sheet. Successful completion of this course will earn you 4 CEUs. 5) A blank duplicate answer sheet may be copied for additional course participants.

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5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ

AUTHOR
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EDUCATIONAL OBJECTIVES
After reading this course, the clinician will be able to do the following:

1. Learn basic terminology, history and progress of the development of dental laser technology.
2. Understand the principle clinical applications of dental lasers in both soft and hard tissue procedures.
3. Review the basic advantages of laser technology in the dental practice.

INSTRUCTIONS
All questions should have only one answer. Grading of this examination is done manually. Participants will receive course results in the mail within two to three weeks after taking an examination.

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