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Enamel demineralization prevention by eight treatments in full-banded orthodontic patients

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OBJECTIVE: Document clinical performance of eight treatments in enamel demineralization prevention.

METHODS: Practice-based, controlled clinical trial. 328 patients (95% completed), 9-18yrs, 56% male, none users of fluoride (F) supplements or F-water, all users of OTC-F dentifrice, all full-banded-orthodontic cases. Assigned randomly to 8 groups: **daily** (1)Xylitol gum-tablets-dentifrice (Epic) 6gm/day; **F-2x/day** (2)Clinpro5000 ppmF; (3)PreviDent5000 ppmF Plus or Booster; (4)MI-Paste-Plus amorphous calcium phosphate+900ppmF; **treatment each 6-8 weeks** (5)HealOzone 2100ppm O_3-gas 1min/arch; (6)VarnishAmerica 5%NaF-varnish all tooth surfaces; **combined** (7)VarnishAmerica-PreviDent5000; **control** (8)patient's own OTC-F dentifrice and regimen. Before banding and each 6-8 weeks recorded: saliva pH and flow rate, oral hygiene, compliance, ATPase activity, foods eaten, full-color close-up images of all anterior and pre-molar teeth. Demineralization defined by visual appearance (none, light-to-moderate, severe) and quantified/tooth (ImagePro-Plus, MediaCybernetics) on clinical photographs before, 7days post-debanding, 1yr after treatment discontinued. Statistics: Generalized linear mixed models; teeth clustered by patient.

RESULTS:

Treatment	Estimated Average Percent Demineralization Includes area under bracket cement	Subsets
PreviDent5000	11 ±0.9	
VarnishAmerica	14 ±1.1	
CONTROL	15 ±1.1	
HealOzone	16 ±1.2	
VarnishAmerica-PreviDent5000	17 ±1.0	
Clinpro5000	19 ±1.3	
MI-Paste-Plus	19 ±1.3	
Xylitol	21 ±1.2	

Treatment	Estimated Percent Teeth with NO Demin	Subsets
PreviDent5000	23 ±3.1	
HealOzone	12 ±2.2	
VarnishAmerica	11 ±2.6	
CONTROL	8 ±1.8	
Varnish-PreviDent	8 ±1.7	
Clinpro5000	8 ±1.7	
MI-Paste-Plus	5 ±1.4	
Xylitol	5 ±1.3	

PreviDent5000 Plus and Booster not different; both had significantly less demineralization. Demineralization exceeding Control: Clinpro5000, MI-Paste-Plus, Xylitol. All patients had visually apparent demineralization. Only 5-23% of teeth within the 8 groups had no visible demineralization.

Demineralization predictors: treatment (<0.000), tooth location (<0.000), time in orthodontics (<0.000), age (<0.000), hygiene (0.013), before-study F-supplement duration (0.014). Post-treatment natural resolution of demineralization not related to treatment (0.489), but to demineralization severity and tooth location (both <0.000).

CONCLUSION: All treatments tested failed to prevent all enamel demineralization in any one patient or treatment group.

Enamel demineralization prevention by 8 treatments in full-banded orthodontic patients

#3919

RP Christensen*, BJ Ploeger, LL Gunter

QUESTION

What happens if products claiming enamel remineralization are subjected to real-life natural accelerated demineralization?

STUDY OUTCOME

Only 1 of 7 treatments showed significantly less demineralization than the Control group where subjects used their habitual oral hygiene regimen & own commercial OTC 1000 ppm F dentifrice. These data indicate:

1. Six of the treatments prevented no more visible enamel demineralization than Crest, Colgate, Aquafresh, Aim, etc.
2. Excellent oral hygiene did not eliminate all demineralization.
3. Claims of efficacy in the presence of visible oral biofilm not confirmed.
4. Commercial products promoted for enamel remineralization need real-life testing before market release.

RESULTS

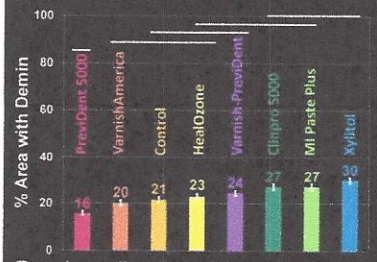
(Demineralization quantified [ImagePro plus software; Media Cybernetics] on clinical image of each tooth 6 days post debond & statistically analyzed.)

Color print each tooth 6 days post debond with & without ImagePro plus polygons to show results to product manufacturers

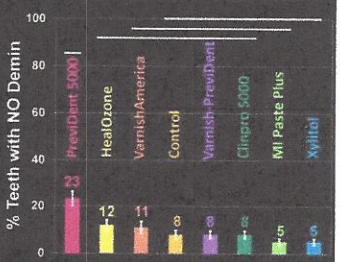
ImagePro plus polygons severe & light-moderate separate for calculations

Only PreviDent 5000 had statistically less demineralization.

mean % AREA **Demineralized** minus area under bracket cement



% TEETH **with NO Demineralization**



Demineralization predictors at <0.000 level: treatment
tooth location
time in orthodontics
age

PATIENT PROFILE

gender = 56% male; 44% female
age = mean 12.3y; range 12-19y
systemic F = 27% of subjects
habitual use OTC F dentifrice = 99% of subjects
oral hygiene grade = mean fair (2.3 in 4.0 scale)
saliva pH = mean 7.2; range 6.0-8.0
saliva flow 1ml/min = 74%
added sugar in diet = high (esp breakfast cereals)
socio-economic = middle class working white

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Surface Disinfection: Can it be effective, safe, and easy?

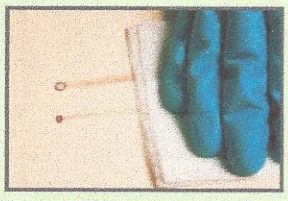
Gordon's Clinical Bottom Line: Infection control is probably *not* your favorite topic, but it is of utmost importance since **most surface disinfectants are *clinically* inadequate**. *For this report, TRAC Research recently tested 5 ethyl alcohol based and 3 other popular products and makes suggestions for you to upgrade handling of contaminated surfaces.*

TRAC RESEARCH

Each patient expects the treatment area to be clean and free of microbes from previous patients. Each member of the dental team expects the workplace to be safe and free of pathogens. No one wants to be sick, even if the illness is not life threatening. Today, critical points in surface disinfection are:

- Dental treatment scatters saliva, blood, crevicular fluid, biofilm, and hard and soft tissue on everything and everyone.
- The contamination comes mostly from aerosols that travel everywhere, but also from smears, splatters, and spills.
- Oral microbes are contained *within* the various fluids and tissues, and are rarely found free on clinical surfaces.
- ***When microbes are mixed with oral complex proteins, all disinfectants do NOT kill equally well.***
- Marketing has misled clinicians, and they continue to choose products that cannot deliver the kill they expect.
- Current industry guidelines direct to clean BEFORE disinfecting which seriously compromises exposure prevention.

This report shows the science, the products, and the procedures necessary for effective, safe, easy surface disinfection in 2015.



We need disinfectants that kill and clean at the same time

1. How can clinicians tell which surface disinfectants kill well?

Chemical formulation is the key. In the U.S., all disinfectants must list ACTIVE and OTHER ingredients on the label using the exact form **shown to the right** for the example Lysol Spray III. Clinicians should always look for this listing on their surface disinfectant.

Example Label

ACTIVE INGREDIENTS:
Alkyl (50%C_{14}, 40%C_{12}, 10%C_{16}) dimethyl benzyl ammonium saccharinate 0.10%
Ethanol 58.00%
OTHER INGREDIENTS: 41.90%
TOTAL: 100.00%

Many years ago researchers characterized the kill potential of chemicals used worldwide for disinfection *(see published works by Block, S.S. and by Morton, H.E.)*. TRAC Research has re-confirmed this work repeatedly since 1989 *(see JADA, Oct. 1989, and many CRA Newsletters and Clinicians Reports)*, testing over 170 products sold in 6 countries. The chart below summarizes results using two pathogens known as difficult to kill with chemicals *(tuberculosis bacteria and polio virus 1 Mahoney Strain)* in the absence and presence of fresh human whole blood:

TABLE 1: General kill potential of commonly used surface disinfectant active ingredients

= Inactivated 3 $\log_{10}$ of a 1 million organism challenge *(99.9% kill)*. = Failed to inactivate 3 $\log_{10}$ of 1 million organism challenge *(99.9% kill)*.

6 Major Active Ingredients used alone or in combination in commercially available environmental surface disinfectants used in dentistry	NO Blood in test system		Fresh Human Whole Blood in test system	
	Tuberculosis bacteria	Poliovirus 1 *(Mahoney)*	Tuberculosis bacteria *(+50% blood)*	Poliovirus 1 *(Mahoney)* *(+10% blood)*
CHLORINE 2.6% by volume	killed	killed	not killed	killed
ETHYL ALCOHOL ≥70% by volume/58% by weight	killed	killed	killed	killed
IODOPHOR	not killed	killed	not killed	not killed
ISOPROPYL ALCOHOL ≥70% by volume	killed	not killed	killed	not killed
PHENOLIC	killed	not killed	not killed	not killed
QUATERNARY AMMONIUM COMPOUND	not killed	not killed	not killed	not killed

Chart Summary:

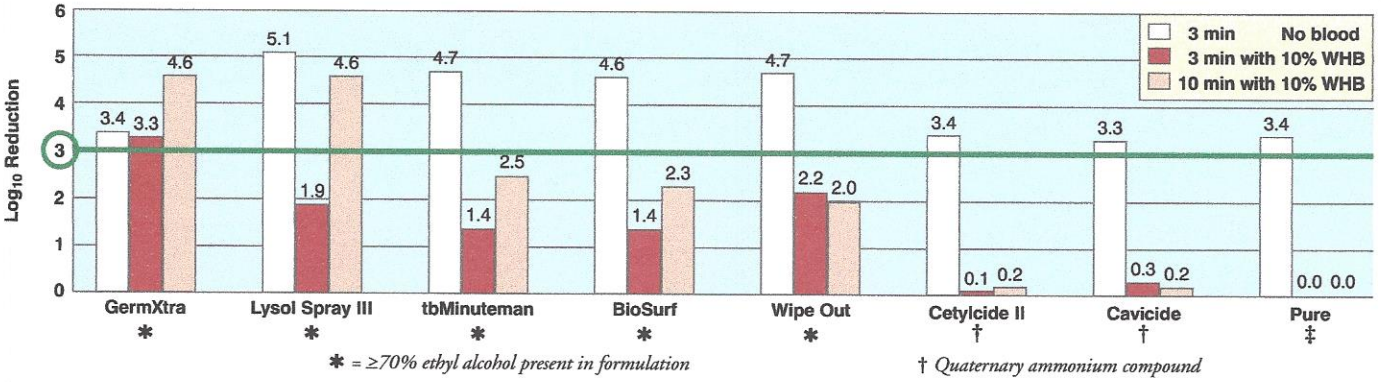
- **Certain formulations based on high ethyl alcohol kill well both in the absence and presence of fresh human whole blood *IF* a specific grade of ethyl alcohol is used along with OTHER INGREDIENTS that allow even spreading, retard evaporation, and aid protein wetting.**
- **Products whose formulations rely primarily on the other 5 chemicals generally fail to kill under the above test conditions.**
- **Clinicians can generally predict a disinfectant's kill by comparing active ingredients on the label to Table 1 above.**

NOTE: A clinician's technique and diligence CANNOT overcome a disinfectant's chemical inadequacy.

2. Do all surface disinfectants kill pathogens equally well?

NO. Generally, if a chemical kills 3 $\log_{10}$ *(99.9%)* of a million organism challenge, it can claim disinfection. Green line below indicates kill limit.

FIGURE 1: Kill profile at *3 & 10 min* of 8 environmental surface disinfectants on poliovirus 1 *in absence and presence of 10% fresh whole human blood (WHB)*



* = ≥70% ethyl alcohol present in formulation

† Quaternary ammonium compound

Graph Summary:

- **All 8 disinfectants tested achieved the necessary 3 $\log_{10}$ kill of poliovirus within 3 minutes, *if blood was NOT present* *(white bars).***
- **With 10% blood, GermXtra passed after 3 and 10 minutes** *(red and pink bars),* **and Lysol Spray III passed after 10 minutes** *(pink bar).*
- **The data illustrate clearly that disinfectant kill is: 1) highly *formulation* dependent; 2) seriously challenged by oral proteins.**

Disinfectant companies know their products fail to kill if complex body fluids are present. For years they have put clinicians at high risk by directing to clean ***before*** disinfecting. This dangerously puts "the cart before the horse" and places the cleaning personnel in harm's way. **We need disinfectants that kill and clean at the same time. TRAC tests show GermXtra and Lysol Spray III accomplish this goal.**

3. There are many products named Lysol, so how do I know which one to buy and the best place to buy it?

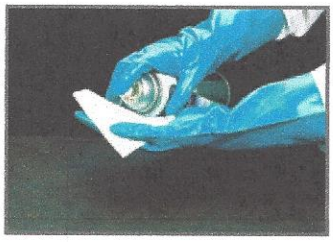
- Best way to KNOW you have the correct product is to check the label ingredients *(see #1 above).* Look for **58% ethanol** *(by weight).*
- Schein, Patterson, Benco, and Burkhart sell the 58% ethanol formulation under the name **Lysol I.C. Disinfectant Spray**.
- Local discount and groceries sell the 58% ethanol formulation under the name **Lysol Spray III** *(NOTE: Crisp Linen scent has least "flowery" scent).*

4. Why do speakers and/or authors tell me not to use ethyl alcohol *(also called ethanol)* for surface disinfection?

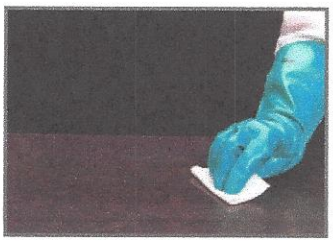
Reasons may include:

- They do not perform disinfectant testing themselves, so they may be easily misled by people with vested interests.
- They do not know that it is the ***formulation***, not just ethyl alcohol alone, that is needed.
- They may not have tested using difficult to kill viruses and clinically relevant types and amounts of human proteins.
- They may have other reasons or biases to promote certain products.
- They may not realize the health and safety of you and your patients are jeopardized by products that fail to kill in the presence of oral proteins.

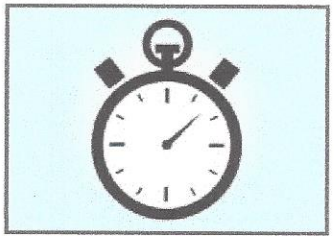
5. Steps for effective, safe, easy surface disinfection.



Step 1. Pre-clean by holding a 4x4 inch cotton filled gauze pad over disinfectant orifice and spray dripping wet to create "custom wipe" just before use. ***Currently, no commercial pre-wet wipes provide kill in the presence of oral proteins.***



Step 2. Generously spread disinfectant evenly and scrub to remove visible debris. Re-wet the gauze pad frequently during wiping. Do not spray directly onto surfaces to avoid uneven wetting and excessive aerosols.



Step 3. Leave surfaces generously wet at least 3 minutes for GermXtra and 10 minutes for Lysol Spray III to allow disinfectant penetration of oral proteins and effective kill.

Step 4. Disinfect pre-cleaned surfaces using a second generously wet 4x4 pad, and leave surfaces damp, allowing to air dry or paper towel wipe to smooth streaks or puddles.

6. Can Lysol Spray III and GermXtra be used to disinfect all types of surfaces?

NO. High ethyl alcohol products need trial before liberal and regular use. ***Some*** rubbers, plastics, paints, and naugahydes require plastic barriers rather than routine treatment with chemicals. **Today, healthcare equipment needs to be upgraded to allow *effective* disinfection after each patient.**

TRAC Conclusions:

Environmental surfaces *can* be disinfected effectively, safely, and easily if efficacious disinfectants are chosen and used correctly. However, both the disinfectant industry and clinicians are urgently in need of change to make this happen routinely. Why change? When a serious pathogen hits unexpectedly, you are ready and all benefit—patients, staff, and doctors. **Currently of 170+ products tested by TRAC Research, only Lysol Spray III in the U.S. and GermXtra in Canada show consistent kill in the presence of human protein debris when used as directed in section 5 above.**

ENVIRONMENTAL SURFACE DISINFECTANTS

critical information (2-2015)

TRAC RESEARCH
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1. Do all disinfectants kill equally well?

No – different formulations and chemical ingredients sold under different brand names kill very differently. This is particularly true when human proteins such as blood, saliva, etc. are present.

2. Should disinfectants be tested by an independent lab to confirm kill claims?

Yes –because marketing and promotional claims can be *very* misleading.

In the U.S., environmental surface disinfectants must kill 99.9% of a specified test organism (3 $\log_{10}$ reduction of a 1 million organism challenge) to be registered as disinfectants by the Environmental Protection Agency (EPA). Unfortunately EPA does not test disinfectants to validate performance data submitted by companies.

EPA has suggested kill of the tuberculosis bacteria as the benchmark for disinfectants used in healthcare. However, our work has shown that disinfectants that can kill the tuberculosis bacteria often cannot kill some of the more difficult-to-kill viruses. Yet, virus kill is not required for EPA registration. However, it is viral infections that present the highest risk to dental clinicians in the U.S. today.

Since 1985 we have accumulated a large database using the tuberculosis bacteria and the virus known as poliovirus I (Mahoney strain) in tests performed in triplicate on well over 150 different disinfectant formulations from around the world. We now know that only high ethyl alcohol formulations (≥70% ethyl alcohol) or chlorine based (≥2.5% sodium hypochlorite) can perform the kill needed in the presence of human proteins such as blood, saliva, crevicular fluid, suppuration (pus), etc, which are ALWAYS PRESENT ON SURFACES IN CLINICAL SETTINGS due to aerosols, spatter, spills, and body contact that occur during every treatment.

However, 70% ethyl alcohol is *NOT* the whole story. To kill in the presence of fresh human whole blood, the formulation requires a specific grade of ethyl alcohol plus surfactants and other trace ingredients to retard evaporation, facilitate even spreading, and aid protein wetting. Our data indicate that only two commercial formulations (Lysol III and GermXtra*) are able to kill in the presence of the human proteins enumerated above, and penetrate to kill the organisms trapped within.

3. Should I clean *before* I disinfect?

Yes, clean – but use a generous coating of a disinfectant that kills in the presence of clinically relevant proteins as the cleaner (Lysol III or GermXtra*). Then after removal of the visible debris, re-apply the Lysol III or GermXtra* for the disinfection step. In other words, spread Lysol III or GermXtra* twice – once to clean and once to disinfect.

Because most disinfectants are NOT able to kill in the presence of human proteins, clinicians have been directed to clean before they disinfect. Unfortunately, clinicians have chosen to clean with products that do not kill in the presence of human proteins. This forces the cleaning person into direct contact with contaminated surfaces at a time when the organisms are most likely to be still viable. *INSTEAD*, surfaces should be spread generously with a broad spectrum disinfectant that kills in the presence of proteins.

*GermXtra is not sold currently in the U.S.

OVER

4. Why is it a bad idea to spray disinfectants directly onto surfaces?

There are three answers to this question: (1) Spraying leaves many areas uncovered with liquid between the spray droplets in which organism kill does not occur; (2) *All* disinfectants are strong chemicals that should not be aerosolized; and (3) Hand pump spray containers used by most for direct application draw in air that is used to expel the liquid. Exposure of the disinfectant chemicals to air degrades their kill potency.

INSTEAD OF SPRAYING DIRECTLY ONTO THE SURFACE – spray liberally into an applicator, such as a 4x4" gauze sponge, and then use it to spread the disinfectant evenly over the surface to be disinfected. The surface should be left generously wet for a period of time to allow the disinfectant to penetrate and kill the microorganisms. This wait period is called "contact time". *All* disinfectants require a contact time that varies according to the formulation of the disinfectant. Directions on many disinfectant containers specify 10 minutes. Most clinicians make the mistake of wiping sprayed surfaces too quickly after application.

5. Are pre-wet wipes, such as the popular CaviWipes, a good solution for surface disinfection?

No—for two reasons: (1) The quaternary ammonium compound chemical used in this product (and most other wipes) is neutralized by human proteins which exposes the user to any pathogens present; and (2) The pull-out dispensing exposes the chemicals on the wipes to air degradation and the wipes to drying.

We have tested many different brands of pre-wet wipes, and NONE achieve a broad spectrum kill, either in the absence or presence of human proteins. For this reason we consider pull-out-dispensed pre-wet wipes to be dangerous to both patients and clinicians in clinical settings.

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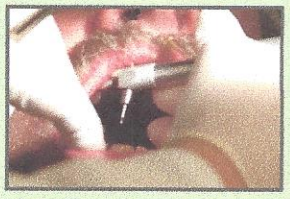
Do lasers added to scaling/root planing improve periodontal outcomes?

Gordon's Clinical Bottom Line: Lasers have established firm niches in medicine over many years. Dental applications have been slower to develop and are often controversial. Dental uses tried so far include resin polymerization; tooth bleaching; endodontic canal disinfection; cutting of enamel and dentin; soft tissue surgeries; and treating periodontitis after scaling and root planing. Some of these applications have disappeared, others remain—but none has flourished to the point of replacing conventional methods. The current question is: Do lasers used after scaling and root planing improve the outcome? *This question received extensive effort from CR's human studies team (TRAC Research). You will be interested in their findings.*

TRAC RESEARCH

These studies were initiated at the request of many clinicians nationwide to verify reports from laser companies and clinicians claiming superior clinical outcomes when lasers were used after scaling and root planing *(SRP)* in the treatment of periodontitis. These studies were designed to compare ***SRP Alone to SRP+Laser.*** They do not compare the different laser wavelengths. The studies address 4–6mm pockets only because this was the range laser companies promoted for use of their instruments by general dental practices. Specific laser ***claims*** of interest to TRAC Research were:

Claim 1. Laser use results in pocket depth improvements substantially better than SRP Alone.
Claim 2. Laser use after SRP sterilizes the pockets.
Claim 3. Laser use resolves bleeding and suppuration on probing better than SRP Alone.
Claim 4. Laser treated patients often do not require anesthetic and experience less post-op pain.
Claim 5. Post-op laser biostimulation speeds healing and increases bone regeneration.



CO_2 laser being used in treatment of periodontitis. Is it helpful?

The goal was to collect *actual clinical data* from laser-company-trained general dentistry practitioners who used lasers routinely in periodontal treatment. TRAC researchers documented the clinical proceedings and outcomes and performed the microbiology. The clinicians selected the patients per the study inclusion/exclusion criteria and treated them according to their laser company's protocol, using the techniques and accessory instruments specified by each laser company. **Results showed none of the five claims could be confirmed regardless of the laser, the clinician, or the patient in the test. Important information follows on pages 2 and 3.**

1. Methods: Two separate studies were performed

- **Study #1** *(Oct 2008–Feb 2010)*
  - 30 patients; 8 clinicians; 4 laser wavelengths *(**CO_2**=Deka PerioPulse; **Diode**=Ivoclar Vivadent Navigator; **Er-Nd:YAG**=Lares [now Technologies4Medicine] PowerLase AT; **Nd:YAG**=Millennium PerioLase MVP-7)*
  - 5 microbiology labs *(Accugenix, DE; Forsyth Institute, MA; Hain Diagnostics, Nehren Germany; Oral DNA Labs, TN; TRAC Research, UT)*
  - First 4 patients were treated with SRP+Laser only. When no dramatic results were observed, the remaining 26 patients received split mouth treatment using SRP+Laser on one quadrant and SRP Alone on the opposite quadrant
  - Both quadrants were treated the same day and follow-up data collected at 3 and 6 months
- **Study #2** *(Mar 2010–Sept 2012)*
  - 10 patients; 4 clinicians; 2 laser wavelengths *(**CO_2**=Deka PerioPulse and **Er-Nd:YAG**=Lares PowerLase AT)*
  - This smaller study was designed to increase the amount of data collected by:
    (1) Collecting all data monthly instead of quarterly, except pocket depths which were collected before treatment, 6 and 12-months post op
    (2) Microbe samples collected on treatment day after each step as well as before treatment, 1, 2, 3, 6, and 12 months
    (3) Both paper point and saliva DNA collection kits used
    (4) Periodontal susceptibility testing performed
    (5) All four quadrants treated the same day with one SRP Alone quadrant as the control
    (6) Perio-pathogen specific antibiotic(s) administered per Hain DNA report suggestions

See full methods: www.CliniciansReport.org Home Page under Complimentary Information.

2. Critical problems that call into question results of past and present clinical studies on lasers in perio

- **Energy output at laser working tip varies during clinical use.** Laser design, operator technique, and lack of proper maintenance cause this. Energy can cease altogether intermittently with some laser/operator combinations. Yet no way is provided by any laser company to indicate real time output at the working tip ***during use.*** *How can effects of laser energy be studied if it ceases during treatment?*
- **Clinical techniques ignore basic tenets of microbial transmission.** The same probe, scaler, and laser tip are used throughout the oral cavity deep within both infected and non-infected pockets, thereby causing these instruments to become ***inoculating instruments.*** Yet bacteria are recognized universally as an important factor in the etiology of periodontitis. *(NOTE: Our tests showed the laser tips did not self-sterilize as claimed, but after contamination required operation in excess of 16 seconds outside the oral cavity for organism kill on metal or sapphire tips or clipping off the used portion of fiber tips—and none of this was done between pockets by any clinician in this study.) How can status of microbes in a pocket be monitored after treatment when new organisms are added repeatedly by clinicians?*
- **Identification of organisms in periodontal pockets is imprecise.** Despite perceptions that DNA testing gives ultimate data, there are significant problems such as: (1) DNA identifies both live and dead organisms, thus confounding organism kill counts; (2) The different labs we used did not agree even though portions of the same samples were sent to each; (3) Results from the saliva and paper point DNA kits often did not agree, and when we tested their accuracy by sending known organisms, they reported organisms not sent and/or failed to report those that were sent. *We concluded that the current DNA kit tests for perio-pathogens need further refinement.* However, use of culturing also has serious problems such as inability to grow some organisms with current methods and human handling error. *How can the contribution of specific microbes be determined without precise identification of **viable** organisms involved?*

Do lasers added to scaling/root planing improve periodontal outcomes? *(Continued)*

3. Results below are from *Study 2 only* comparing SRP Alone *vs.* SRP+CO_2 or Er-Nd:YAG lasers

- **Claim 1: Pocket Depth Resolution**

(This study looked specifically at 4–6mm pockets because this is the range promoted by laser companies for treatment by general practitioners.)

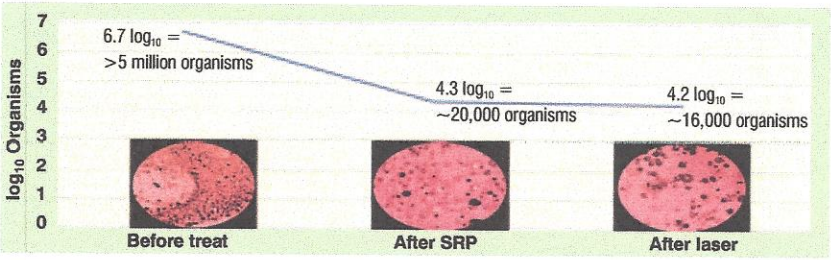
– **6mm pockets** showed ***statistically better pocket improvement at 1 year when treated with the CO_2 laser after SRP (p=0.020),*** with an average improvement of 1.045mm more than with SRP Alone. However, this point needs confirmation in studies that include more patients and more 6mm and deeper pockets *(total 6mm pockets in this study = 63).* ***There was no difference in 6mm pocket depth resolution when comparing the Er-Nd:YAG laser to SRP Alone.***

– **4mm and 5mm pockets** showed ***no difference between SRP Alone and SRP+Laser using either laser,*** regardless of how pockets were analyzed, using many different statistical approaches and combinations of data.

– **1–3mm sulcus depths** were treated to determine the response of shallow pockets to SRP Alone and SRP+Laser. ***1–3 mm pockets treated with the Er-Nd:YAG laser did not recover as well as those treated with SRP Alone (p=0.015). However, the CO_2 laser used on 1–3mm pockets showed no difference between SRP Alone and SRP+Laser.***

- **Claim 2: Pocket Sterilization**

– ***Neither SRP Alone nor SRP+Laser sterilized any pocket, on any patient, at any time regardless of laser wavelength used.*** However, use of ultrasonic scalers *(Cavitron or PiezonMaster)* set on ***high water*** eliminated a substantial number of organisms *(2.5 log_{10})*. Follow-up with the lasers after SRP reduced microbes further by only a small amount *(0.1 log_{10})*. ***See graph below.*** The actual clinical pocket shown below contained more than 5 million organisms before treatment. The ultrasonic scaler on high water reduced the organisms to about 20,000. Er-Nd:YAG follow-up further reduced the organisms to about 16,000. However, this quantity of remaining organisms are able to ***re-populate rapidly*** by cell division which proceeds logarithmically to produce enormous numbers in just 24 hours. The ***Petri dish images*** show the appearance of the microbial colonies on anaerobically cultured blood agar plates. Note the presence of the characteristic black pigmented colonies typical of some perio-pathogens.

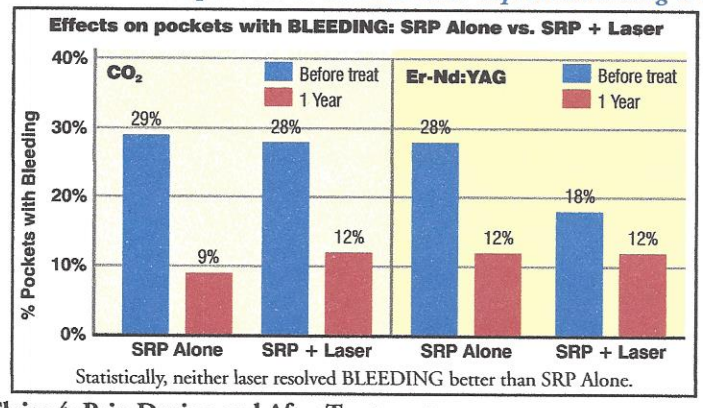


- **Claim 2: Pocket Sterilization** *(Continued)*

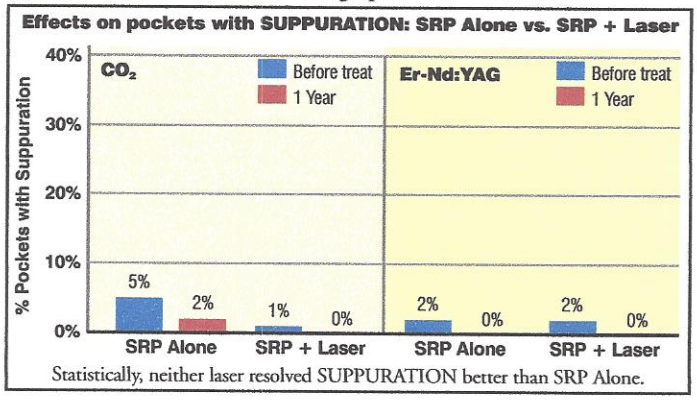
– ***Microbe reductions did not correlate with pocket depth improvement.*** Others have reported similar findings *(Ximenez-Fyvie, et al; J Clin Periodontal 2000, 27:637, page 640).* This contradicts clinical perceptions that decreasing the microorganisms will result in pocket depth resolution. Our data may support current thought that while the bacteria are important in initiating inflammation, it is the inflammation that drives the disease. *(No steps were attempted in this study to measure or control inflammation.)* In Study 2, antibiotic type, dosage, and duration suggested by the Hain Diagnostics DNA test was initiated immediately following treatment to assist in lowering microbe numbers. Although microbe numbers ***were*** lowered, there was only very low correlation with pocket depth improvement *(0.1–0.4).*

- **Claim 3: Bleeding and Suppuration Resolution**

– ***Neither the CO_2 nor the Er-Nd:YAG laser improved bleeding or suppuration over SRP Alone.*** See graphs below.



Statistically, neither laser resolved BLEEDING better than SRP Alone.



Statistically, neither laser resolved SUPPURATION better than SRP Alone.

- **Claim 4: Pain During and After Treatment**

– Patients rated pain *(escalating scale of 1–10)* immediately after treatment, at one month, and 6-months post-op. ***Pain ratings did not differ for SRP Alone and SRP+Laser,*** and none of the patients correctly identified the SRP Alone quadrant on treatment day or at any time based on pain. ***All patients required anesthetic for treatment.*** Without anesthetic, only very cursory treatment could be tolerated.

- **Claim 5: Post-op Biostimulation**

– ***No effect, either good or bad, could be identified for biostimulation.*** *(NOTE: Biostimulation used the Nd:YAG laser to emit laser energy to interact with tissue to stimulate circulation, healing, and bone growth. This was done for some patients, while others served as controls.)*

Do lasers added to scaling/root planing improve periodontal outcomes? *(Continued)*

4. Important Observations

- **Laser advantages in soft tissue surgery.** Benefits of lasers for *soft tissue surgery* in both dentistry and medicine are well accepted. Their simultaneous cut and coagulate capabilities can be useful in removing sulcular tissue to gain ultrasonic scaler access and contouring papillas. They also can cut next to metal and uncover implants without harming bone or damaging implants. *It is the claims related to periodontitis that need validation.*
- **Critical importance of homecare.** We concluded that we could treat 4–6mm pockets with or without a laser, but we could not achieve optimal results without patient cooperation. Overall patient homecare compliance in this study was rated fair. *Neither SRP Alone nor SRP+Laser treatments were substantial enough to overcome effects of casual homecare.*
- **Clinician and patient perception of laser efficacy:** We noted that both clinicians and patients were motivated by the laser use. However, SRP Alone with the ultrasonic scaler on high water setting resulted in the same or better outcome than when a laser was added. Interestingly, not all clinical studies of lasers in periodontitis include an SRP control. However, it is notable that ***all*** *laser companies use their laser in periodontitis treatment* ***after SRP.***
- **Laser stimulation of bone growth and healing not seen:** Clinically, we did not observe a systemic boost of healing sometimes claimed as a laser energy/soft tissue interaction, but we refer readers to Section 2, Bullet 1, on page two noting inconsistent laser energy output at working tips and no way for clinicians to monitor the tip output during use. ***We concluded that laser use in periodontitis treatment is in an early crude stage and needs significant refinement of both the lasers and the clinical techniques.***
- **Unique clot produced by laser use.** Treatment with all the lasers studied produced a seeping, sticky, lymph-rich clot typical of burn wounds, and noticeably different from the RBC-rich clots produced by scalpel surgery and SRP with hand instruments. However, the difference in the clots did not result in differences in clinical outcomes.
- **Fees for SRP Alone *vs.* SRP+Laser.** We noted substantially higher fees for SRP+Laser vs periodontal SRP Alone *(3 to 5 times higher). In light of results from these two studies, and others in the literature, showing little to no significant differences in clinical outcomes in SRP Alone vs SRP+Laser, substantially higher fees cannot be justified at this time.*

TRAC Conclusions:

These studies did not confirm 5 frequent claims of superiority for lasers used after scaling and root planing in treatment of periodontitis. SRP Alone was either the same or superior to SRP+Laser EXCEPT the CO_2 laser in 6mm pockets showed pocket depth improvement at one year that was *statistically* better than SRP Alone. This result is intriguing, but requires confirmation in additional studies. For now, it appears lasers are not the "magic bullet" claimed for periodontitis treatment—and definitely cannot be justified for "pocket sterilization" after SRP.

Sincere thanks to the many people who worked with us in these studies, including the clinicians, report reviewers, and the Brigham Young University statistical team.

What is CR?

WHY CR?

CR was founded in 1976 by clinicians who believed practitioners could confirm efficacy and clinical usefulness of new products and avoid both the experimentation on patients and failures in the closet. With this purpose in mind, CR was organized as a unique volunteer purpose of testing all types of dental products and disseminating results to colleagues throughout the world.

WHO FUNDS CR?

Research funds come from subscriptions to the *Gordon J. Christensen Clinicians Report®*. Revenue from CR's "Dentistry Update®™ courses support payroll for non-clinical staff. All Clinical Evaluators volunteer their time and expertise. CR is a non-profit, educational research institute. It is not owned in whole or in part by any individual, family, or group of investors. This system, free of outside funding, was designed to keep CR's research objective and candid.

HOW DOES CR FUNCTION?

Each year, CR tests in excess of 750 different product brands, performing about 20,000 field evaluations. CR tests all types of dental products, including materials, devices, and equipment, plus techniques. Worldwide, products are purchased from distributors, secured from companies, and sent to CR by clinicians, inventors, and patients. There is no charge to companies for product evaluations. Testing combines the efforts of 450 clinicians in 19 countries who volunteer their time and expertise, and 40 on-site scientists, engineers, and support staff. Products are subjected to at least two levels of CR's unique three-tiered evaluation process that consists of:

1. Clinical field trials where new products are incorporated into routine use in a variety of dental practices and compared by clinicians to products and methods they use routinely.
2. Controlled clinical tests where new products are used and compared under rigorously controlled conditions, and patients are paid for their time as study participants.
3. Laboratory tests where physical and chemical properties of new products are compared to standard products.

THE PROBLEM WITH NEW DENTAL PRODUCTS.

New dental products have always presented a challenge to clinicians because, with little more than promotional information to guide them, they must judge between those that are new and better, and those that are just new. Due to the industry's keen competition and rush to be first on the market, clinicians and their patients often become test data for new products. Every clinician has, at one time or another, become a victim of this system. All own new products that did not meet expectations, but are stored in hope of some unknown future use, or thrown away at a considerable loss.

To help clinicians make educated product purchases, CR tests new dental products and reports the results to the profession.

Clinical Success is the Final Test

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Rella Christensen, PhD

Rella Christensen, PhD, is the Team Leader of TRAC Research which is the long-term research section of the CR Foundation, an educational non-profit foundation formerly known as Clinical Research Associates. Dr. Christensen co-founded Clinical Research Associates and directed the organization for 27 years, then served as chairman of its Board of Directors for 2 years. In 1960, she received a BS in dental hygiene from USC. She practiced hygiene for over 25 years and worked as a dental lab tech for three years. She earned a PhD in physiology with an emphasis on microbiology from BYU in 1986, and completed a post-graduate course in anaerobic microbiology at Virginia Polytechnic State University.

SEALANTS

A procedure worth revisiting

You can improve the success rates of the sealants you place. Here are a few tips, including using an assistant, magnification, disinfection – and charging accordingly.

Pit and fissure sealant use has been urged and researched actively for over 30 years,[1-2] yet dentists' enthusiasm for the procedure has been only moderate, and pits and fissures remain the most common site of dental caries.[3] Why?

One clinician summed up his sealant experiences humorously stating that the kids act as though he is killing them, the parents act as though he is ripping them off, and if a sealed tooth develops caries he becomes a confirmed criminal in the eyes of both the child and parent! Why would sealed teeth develop caries?

- **Are we applying sealants after carious lesions have progressed too far?**
- **Are we failing to achieve a seal between the uncut acid etched enamel and sealant?**
- **Are we underestimating the pathogenic potential of the organic plug that generally remains at the base of pits and fissures?**
- **Are we expecting more than is possible from a thin layer of resin on active occlusal surfaces?**

It's anatomical

Observant clinicians have been writing about susceptibility of pits and fissures to carious lesions for years (see Figure 1) and suggesting conservative excavation and insertion of restorative material.[4-7] However, widespread use of these recommendations never occurred. Hesitancy of clinicians to cut virgin teeth and costs to the patient in the absence of frank disease were probable deterrents. With the advent of acid etch-resin adhesive dentistry in 1955,[8] treatment of pits and fissures prophylactically without cutting into virgin teeth became possible, and minimally invasive dentistry was born. However, resin-based sealants have not yielded the expected public health impact. Why not?

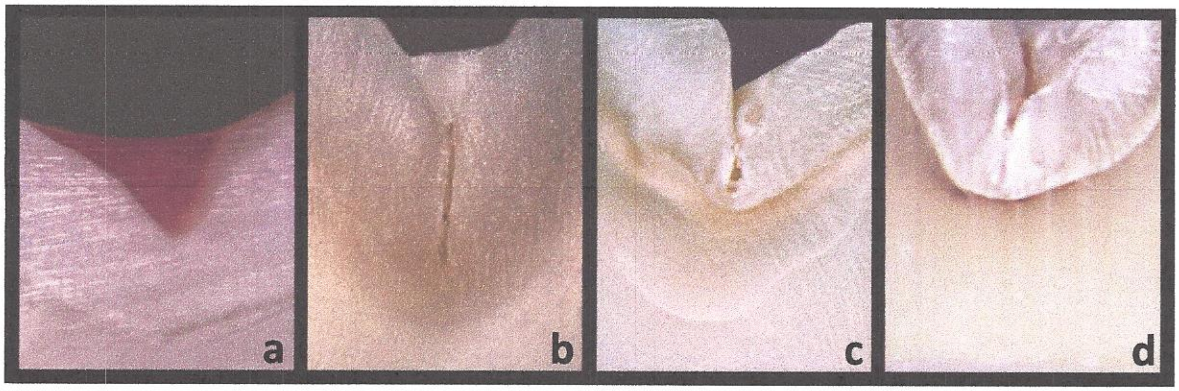

Figure 1. These images show four different human teeth sectioned longitudinally to expose fissure anatomy internally. Image A shows pink sealant over a caries free fissure with ideal anatomy, while B shows white sealant over a caries free defective fissure filled with organic debris and microorganisms. C and D show how fissures with novel anatomy can be susceptible to decalcification (C) and develop into carious lesions penetrating into dentin (D).

Updated from February 2007 Dental Products Report

Pits and fissures in human teeth predispose them to dental caries. Calcification of tooth buds begins at cusp tips and proceeds downward towards the eventual pits and fissures.[9] Often, there is incomplete enamel closure where the calcifying planes meet. This allows openings that penetrate to dentin (See Figure 2). Another problem is the inability to clear dental plaque daily at the base of pits and fissures. Figure 3 shows scanning electron microscope images of plaque within the pits and fissures of teeth that appear clinically "clean". Restricted visual access in the most posterior areas of the oral cavity compounds both of these problems.

The problem is us

I submit that sealant placement as it is practiced in the U.S. today is inherently flawed due to the desire for sealants to be a fast, easy, inexpensive procedure. Staff personnel are expected to work without an assistant to achieve and maintain a dry field and visual access on young children's most posterior teeth – and they are expected to obtain a seal in the presence of debris at the base of the pits and fissures! Furthermore, many view sealants as a fix for questionable borderline teeth where it is impossible to confirm absence of carious lesions. They hope the sealant will "arrest " caries, if present. Yet clinicians removing sealants see that caries can, and do, progress under sealants. In a study we reported in 2001,[10] 25 subjects 22-29 years of age gave permission to replace sealants placed 10+ years earlier by 25 different private practices in 21 U.S. states where they were patients as children. We found 147 of 159 teeth (92%) had carious lesions under the sealants, and 42 of the 147 lesions (29%) were unusually large. Only 12 of the 159 teeth (8%) remained caries free at 10+ years after sealants were placed.

How long should a sealant be expected to protect against dental caries? Sealant life expectancy has not been defined. Although partial loss of sealants has been described in most clinical sealant studies, replacement frequency recommendations are nonexistent, and studies have not reported on the effectiveness of repaired sealants.

The high percentage of carious lesions under the unsupervised sealants in our young adult subjects indicates several important points. First, sealants need close surveillance, second, sealants often do not arrest caries, and third, sealants do not serve indefinitely. The study also suggests that sealant placement may be more demanding technically than acknowledged. To be successful in preventing the ingress of microorganisms, an excellent adhesive bond of resin to tooth is needed. Achieving this on a child's most posterior partially erupted teeth where rubber dam isolation is impossible requires time, patience, and skill– generally more so than for a Class 1 restoration. Yet the average reimbursement for sealant placement in a molar is $38, while a Class 1 restoration in the same tooth is $120 in the U.S.[11] Perhaps it is time to review the value of caries prevention vs. caries treatment.

Originally, sealant placement was taught as a procedure for recently erupted teeth that were known to be caries free. See Figure 4. However, because placement at this stage was difficult and time consuming, and the teeth were not always available at the ideal time, treatment quickly moved to application on fully erupted teeth. Today some researchers suggest people of any age could be sealant candidates.[12-14] However, when sealing fully erupted teeth inadvertent sealing of carious lesions raises questions that have never been answered fully. Although researchers have reported sealing arrests caries,[15-18] clinicians have observed otherwise.

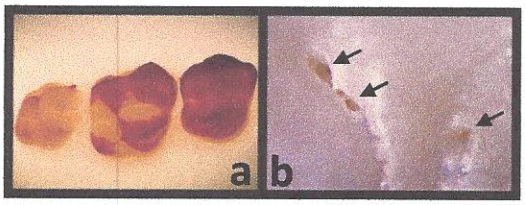

Figure 2. Image A shows tooth buds from a human fetus after staining with alizarin red S dye to discriminate calcified from non-calcified tissue. Note that calcification starts at cusp tips (left bud) and moves downward (middle bud) and coalesces to form the fissures (right bud). Image B shows areas in fissures of a fully formed extracted human tooth where the enamel did not fuse fully in the fissures, leaving holes that penetrate to dentin.

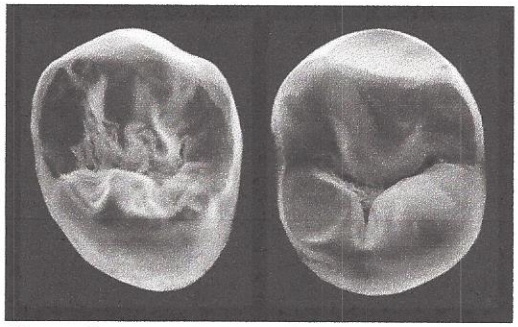

Figure 3. Scanning electron microscope images show how fissures of teeth *in situ* retain dental plaque.
Tooth fissures are never totally free of dental plaque because there is no homecare instrument or method that penetrates completely. Air polishers or light air abrasion are the most conservative ways to clean fissures thoroughly before sealant placement.

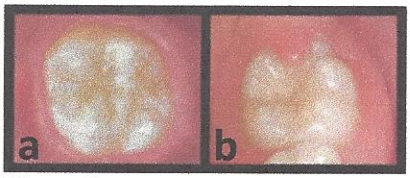

Figure 4. Image A shows a tooth that has erupted to a stage ideal for sealing, with its entire occlusal surface exposed and no carious lesions present. Image B shows a tooth with the distal still covered by operculum tissue, which challenges thorough cleaning and isolation during sealant placement. This tooth should receive fluoride varnish at two month intervals until it is ready for sealant.

The critical clinical questions are: (1) What can we do to improve sealant placement? and (2) How can we improve remuneration for the time and effort required?

To improve sealant placement I suggest the following steps:

1. **Obtain an assistant. If cost is prohibitive, hire and train a teenager to come after school, and schedule sealants only when the assistant is present.**
2. **Watch patients nearing 6 and 12 years of age carefully for tooth eruption, and seal after the teeth have cleared the soft tissue while they are caries free (See Figure 4). If operculum is retained for an extended time, apply fluoride varnish every other month until the teeth can be cleaned well and sealed. (All four molars may not be available for sealant at the same time.)**
3. **Isolate well and clean pits and fissures thoroughly using an air polisher. Use sodium-free abrasive (Cavitron Jet-Fresh by Dentsply Preventive) for better flavor (See Figure 5). If caries is suspected, use air abrasion or an erbium laser to explore and remove caries.**
4. **If a young child will not tolerate the air polisher, isolate well and clean the pits and fissures as thoroughly as possible using water only on a special small brush that fits a latch attachment (See Figure 6, ICB Brush by Ultradent).**
5. **Remove isolation and rinse thoroughly using the spray mode on the air/water syringe while simultaneously evacuating.**
6. **When air polishing is used, an extra acid etch application step is required to neutralize the basic pH of the abrasive powder before acid etching for sealant retention. (The sodium-free Jet-Fresh powder also has a basic pH.) Neutralize by placing acid etchant onto the teeth under treatment and leaving it in place just long enough for the rapid bubbling of the acid-base reaction to cease. DO NOT allow the acid to contact surfaces that will not be sealed. (Use of magnification is more than helpful – it is mandatory to control the chemicals used with sealants.) Rinse again thoroughly as described in Step 5 above.**
7. **Isolate well and dry thoroughly.**
8. **Disinfect all pits and fissures well using a 5% glutaraldehyde/HEMA based desensitizer for two 60-second applications. (Gluma Desensitizer by Kulzer, MicroPrime G by Danville). Remove residual liquid with high velocity suction. DO NOT rinse and DO NOT allow the glutaraldehyde to contact soft tissue.**
9. **Apply an adhesive directly over the damp glutaraldehyde/HEMA surface and spread it to a thin coating using a gentle stream of air.**
10. **Apply the sealant, exercising care to keep it within the pits and fissures. Remember to seal all the buccal grooves, plus distal lingual grooves on upper molars.**
11. **Check occlusion, and adjust if needed.**
12. **Plan to MONITOR the sealants forever with the same zeal given to restorations. At recalls, apply fluoride varnish to sealant treated teeth. (Thin resin on occlusal surfaces is subject to cracking and breaking away. I would not repair broken sealants. Instead remove the residual resin and replace the sealant using the steps above.)**

To improve remuneration for more careful sealant placement I suggest the fee be related to the time used clinically. A flat fee makes no sense when the time needed can vary dramatically, depending on the patient's cooperation.

Conclusion

In conclusion, I believe we can do a better job placing and monitoring sealants. Several steps have been suggested above that are not generally performed. They include routine use of an assistant and magnification; when possible, sealing teeth when newly erupted and caries free; routine use of an air polisher (and air abrasion if caries is suspected); use of a potent disinfectant (5% glutaraldehyde/HEMA) followed by an adhesive before sealant placement; applying fluoride varnish at recalls; and monitoring forever to the same degree that restorations are monitored. Consider your sealants to be a "preventive barrier" that you must keep intact!

Figure 5. Cavitron Jet-Fresh by Dentsply Preventive is a sodium-free abrasive made for air polishers. Its aluminum tri-hydroxide abrasive eliminates the sharp taste of the conventional sodium bicarbonate.

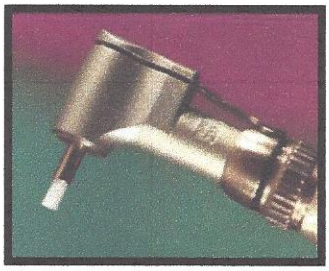

Figure 6. The InterCoronal Brush (ICB Brush) by Ultradent is specially designed to fit slow speed latch attachments. Its small size and short fine bristles can be used to clean pits and fissures in young children who may not allow air polisher use. (However, an air polisher provides optimum cleaning.)

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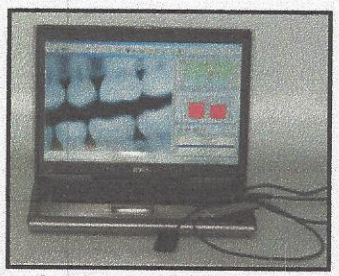
New Caries Detection Systems: Reliable and Accurate

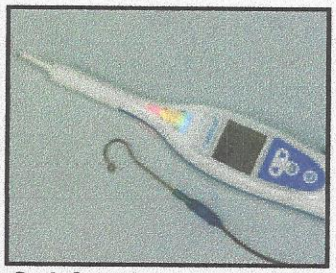
Gordon and Paul's Clinical Bottom Line: It is well known that current dental radiographs, analog or digital, do not show the exact extent of dental caries. Occlusal caries must be relatively large to show definitively on typical bite-wing or periapical radiographs. This is a major void in the profession. Several new methods now on the market identify caries well, and can be used to augment radiographs. However, current caries detection products identify either occlusal or proximal caries, but none identify both reliably and accurately. *The TRAC Research division of CR has performed extensive evaluations to verify the clinical effectiveness of the four products in this research report.*

TRAC RESEARCH

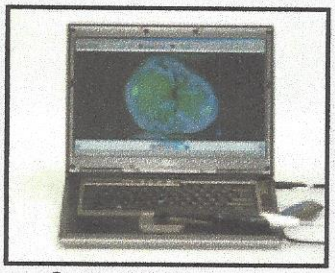
When was the last time you had a patient become hostile when you indicated caries needing treatment or the last time you wondered how to convince a patient that his choices and habits had to change to improve his oral health? Would it help if a neutral team member had technology that showed the patient real-time images of his teeth that identified and highlighted carious areas? Several newer caries detection instruments have this capability. Whether you plan to try to remineralize, seal, or excavate a carious lesion, correct detection is still a critical goal. **This report summarizes results of work by the TRAC Research team using four systems which detected initial carious lesions accurately *in vivo* with no false positives in all 75 teeth scheduled for clinical treatment.**



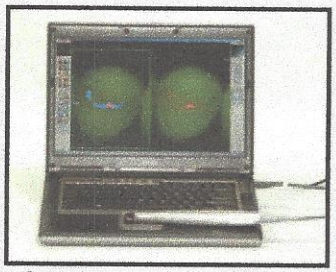
Logicon by Carestream
Interproximal lesion detection on radiographs using grayscale analysis software
(www.carestreamdental.com)



CarieScan Pro by CarieScan
Occlusal lesion detection by AC impedance spectroscopy
(www.us.cariescan.com)



SoproLIFE by Acteon
Occlusal lesion detection using tooth fluorescence
(www.us.acteongroup.com)



Spectra by Air Techniques
Occlusal lesion detection using tooth and porphyrin fluorescence
(www.airtechniques.com)

Minimum computer specs: RAM = 256, hard drive memory = 50 gig minimum, display monitor = 32 bit color minimum, and USB 2.0 port

Similarities and Differences Among the Four Systems

Note: ***Because the systems evaluated differ substantially in the methods used to detect caries, the chart below is not designed as a comparison chart, but rather to show what each product can and cannot do. Clinicians interested in purchasing a caries detection system need to inspect each system and decide which features are most needed in their practice. Currently, no one system has every feature.***

	Retail list price	Comfort of intraoral component	Accurate ID interproximal caries	Accurate ID occlusal caries	Displays clinical appearance before treatment	Clearly indicates caries location to patient	False positives	Indicates caries severity †	Ease and speed of use	Retains record of exam	Allows hard copy for patient	Tabulates results of exam	Possible to use for remineralization monitoring	Easily transfers to major practice management software	Necessary pre-treatment of teeth
1. Logicon	$1995	Good	Yes	No*	No	Yes	None	Yes	Good	Yes	Yes	No	Yes	No	None
2. CarieScan Pro	$2995	Excellent	No*	Yes	No	No	None	No/Yes †	Excellent	Yes	Yes	Yes	Yes	No	Quick dry tooth surface
3. SoproLIFE	$6470	Good	No*	Yes	Yes	No	None	No	Good	Yes	Yes	No	No	Yes	Clean tooth using any method
4. Spectra	$4995	Good	No*	Yes	No	Yes	None	Yes	Good	Yes	Yes	No	Yes	Yes	Analysis Mode: clean any method and dry

* *Device not designed for this use*

No/Yes † *No = FDA wording restrictions defining number readout preclude this use in the U.S.*
Yes = Definition of numbers displayed outside U.S. give clear indication of caries severity

Main Features Summary:

1. **Logicon:** Can monitor tooth density change due to both de- and remineralization on interproximal surfaces displayed by digital radiographs, but its use is restricted currently to the Kodak RVG system only *(Carestream).*
2. **CarieScan Pro:** Easiest and fastest to use and tabulates results of the exam in several different forms, but does not display a real-time image of the patient's tooth during the exam.
3. **SoproLIFE:** The same corded handpiece contains an excellent intraoral camera plus a caries detector. This allows the patient to view the tooth clinically first then with the detector colors superimposed, but the reddish coloration indicating caries is subtle and requires a darkened operatory and some experience to learn to see it on a monitor screen quickly.
4. **Spectra:** Corded handpiece has controls that allow display of caries location and severity. This display is quickly and easily understood by both patients and clinicians, but this device does not have intraoral camera capability to view the tooth as it appears clinically.

New Caries Detection Systems: Reliable and Accurate (Continued from page 1)

Methods

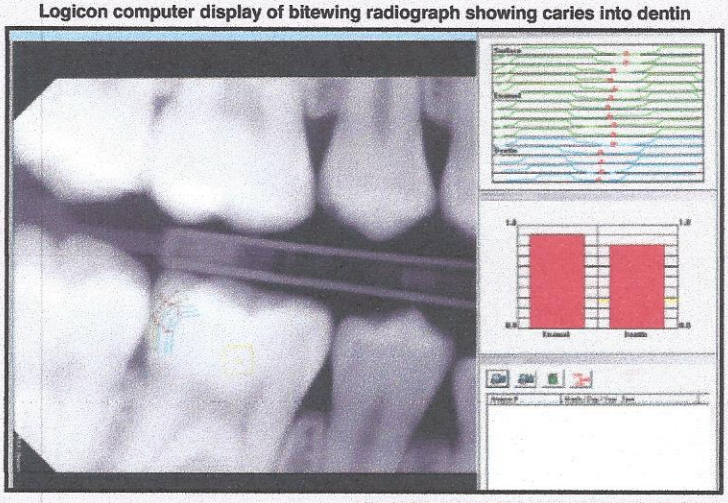
Each patient's bitewing radiographs made on the Kodak RVG system were enhanced, subjected to Logicon software for interproximal caries detection, and saved. The three other caries detection systems were then used in the oral cavity clinically one at a time for detection of initial occlusal caries, and the data were saved. Carious lesions were excavated, cultured *(aerobic and anaerobic)* and photographed during each step of sequential removal of initial enamel, deep enamel, initial dentin, deep dentin, and final prep to validate the caries detection data from the four systems.

How the Systems Detect and Display Caries and What Interferes with Accurate Detection

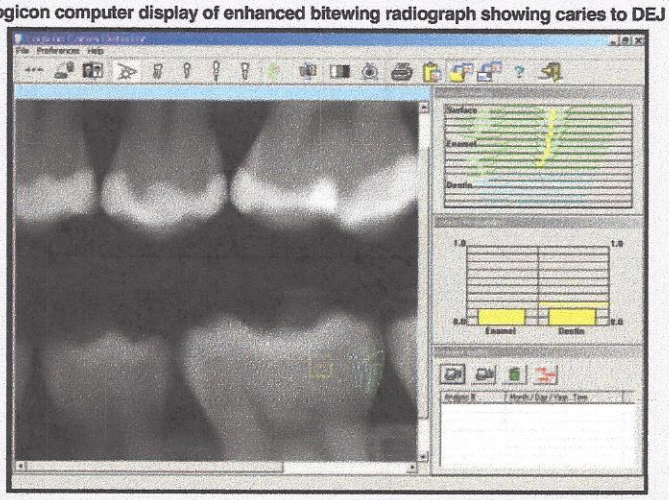
A. Interproximal Caries Detection Systems *(1 system is listed)*

1. Logicon: Analyzes grayscale *(4096 shades of gray currently)*, recognizes caries patterns, and compares to a library of 600 teeth to identify healthy and carious tooth structure on digital bitewing radiographs made on Kodak RVG equipment. The pictures below show computer screen images of data presented for viewing by the clinician and patient, plus clinical images of the teeth during the excavation to prove the system's analysis. Conditions that commonly interfere with detection by this system are: overlapped proximal surfaces, restorations on proximal surfaces, concave proximal surfaces, or artificial radiolucencies caused by some holders.

Logicon computer display of bitewing radiograph showing caries into dentin



Logicon computer display of enhanced bitewing radiograph showing caries to DEJ



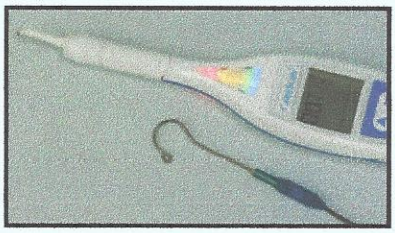
This image shows the tooth displayed on the Logicon analysis above during excavation to document the Logicon findings.

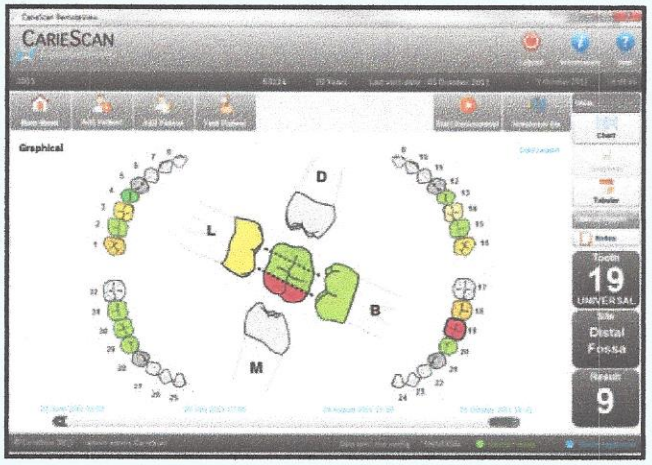
Note: The occlusal lesions shown are not detected by Logicon.

This image shows the site identified by Logicon above and the excavation to document the Logicon findings. Both show caries extended to the DEJ.

B. Occlusal Caries Detection Systems *(3 systems are listed alphabetically by brand name)*

1. CarieScan Pro: Low voltage current is directed through the tooth *(note lip hook in image below)* to evaluate mineral density. A numerical value between 0 and 100 is displayed on the instrument along with color-coded lights. No zeroing is required because the tooth is compared to a library of over 2000 sites to identify healthy and carious tooth structure. *No clinical tooth image is displayed,* but data can be transferred by Bluetooth to proprietary software called RemoteView which both displays and tabulates the examination data in colored graphics *(one example is shown at right).* Conditions that commonly interfere with detection include restored sites, excess saliva, and over drying.





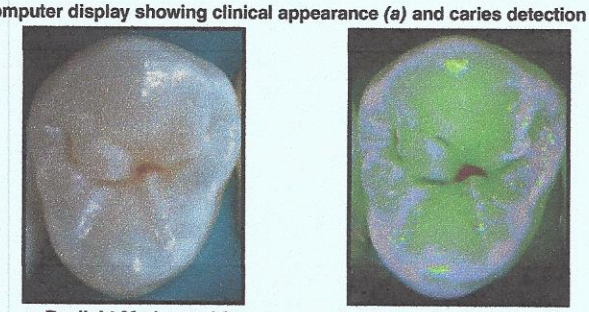
New Caries Detection Systems: Reliable and Accurate (Continued from page 2)

How the Systems Detect and Display Caries and What Interferes with Accurate Detection (Continued)

B. Occlusal Caries Detection (Continued)

2. SoproLIFE: The same handpiece emits white light for intraoral camera imaging or 450 nm LED blue light for caries detection. Conditions that commonly interfere with detection include restored sites, stained surfaces, and calculus in fissures. Also too much light in the operatory during the analysis can impede perception.

Computer display showing clinical appearance *(a)* and caries detection *(b)*

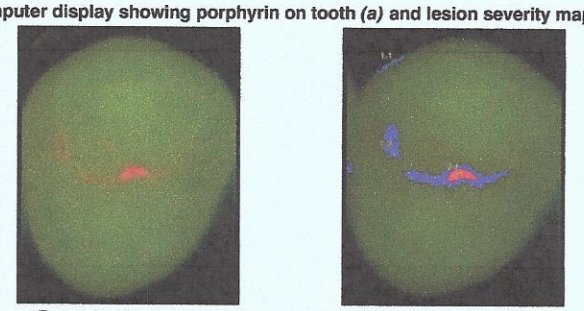


a. Daylight Mode used for intraoral camera image

b. Diagnostic Mode used to indicate lesion location

3. Spectra: Handpiece emits 405 nm LED blue light to show porphyrin metabolites from cariogenic bacteria, and Analysis Mode gives color-coded map and numbers indicating lesion location and severity *(ingress into tooth)*. Conditions that commonly interfere with detection are restored sites and calculus in fissures.

Computer display showing porphyrin on tooth *(a)* and lesion severity map *(b)*



a. Detection Mode used to detect porphyrins

b. Analysis Mode shows lesion location and severity

How the Four Caries Detectors can Improve Patient Treatment

1. Three of the four systems detect initial *occlusal caries* reliably and accurately. Up until now, this has not been possible using traditional methods such as radiographs and visual/tactile examination.
2. Data generated by all four systems helps to dispel patient doubts about legitimacy of caries diagnosis.
3. All four systems give patients a clear understanding of their caries status.
4. Three of the four systems allow patients to see the relative severity of the lesions which enables them to share in decisions on if and when to excavate. Caries severity is not determined easily by the SoproLIFE.
5. All four systems can provide printouts for patients to carry home to consider their oral health status in the privacy of their home.
6. Accurate caries detection followed by lesion monitoring over time to determine lesion arrest, progress, or regress can give patients the opportunity to change habits and choices to conserve irreplaceable tooth structure.

Note: Detection is not a reason to excavate. The dentist and patient must consider past caries experience, lesion size and location, oral hygiene, saliva flow rate, diet, etc. in making a decision on treatment.

Conclusions: All four caries detection systems reported have performed well and better than all previous products in rigorous trials of their accuracy in multiple real-world clinical environments. Because they differ substantially in design, output, and features, clinicians must study the chart above to identify features they need most. Only the Logicon detects *interproximal lesions* reliably and accurately. The other three systems detect *occlusal lesions* equally reliably and accurately. Their ability to detect and record initial *occlusal caries* marks a significant first for dentistry which warrants consideration for routine use by clinicians. Although today there is debate on how to manage initial carious lesions, dental clinicians' responsibility to detect and record caries accurately has not changed.

FOCUS ON: New Zirconia Restorations

Rella Christensen, PhD, discusses the newest in zirconia restorations and how zirconia is changing.

Q: Why is zirconia a hot topic in 2015?

A: This is the year *translucent* zirconia with new formulations, new molecular structures, and new physical properties became available. More translucent formulations open the option for zirconia use on anterior *and* posterior dentitions, and start an aggressive race among competing companies to win market dominance. Since all the companies are using similar raw product from Japan or China, their challenge is to develop unique characteristics that distinguish their product. BruxZir (Glidewell Laboratories) has dominated the zirconia market in the United States this past 6 years, with more than 7.5 million units sold, but its lack of translucence precluded its use in many situations. Competitive products want to fill this niche. A more translucent zirconia called BruxZir Anterior (Glidewell) is now available, and is ready to take on the new competitors. Clinicians wonder how the multiple brands of both the translucent and nontranslucent zirconia formulations differ from each other and have questions about their indications and contraindications.

Q: Current advertisements state translucent zirconia formulations are as aesthetic as lithium disilicate, but stronger, implying that they are longer lasting. Is this true?

A: Maybe. Our eyes tell us that translucent zirconia can equal lithium disilicate aesthetics. We also *see* that zirconia flexural strengths are substantially higher than lithium disilicate (600 to 650+ MPa for translucent zirconia versus 300 to 350+ MPa for lithium disilicate). However, we need *clinical* data before we know if translucent zirconia will outperform lithium disilicate, a material that has established a record throughout many years for excellent aesthetics and service in both its CAM and pressed versions. Yet, there have been fractures of lithium disilicate restorations, particularly in posterior multiunit cases. Clinicians would like to have a more durable aesthetic ceramic for posterior use, and translucent zirconia may be that material.

Q: What was done to gain more translucence? And with this gain, do I lose anything?

A: More yttria oxide has been added and firing cycles have been altered. These changes result in a higher ratio of cubic to tetragonal molecules, and thus, more translucence.

However, with the gain there are losses. The physical properties of the new translucent zirconias differ from the original more opaque formulations used for substructures in early 2000, and later for BruxZir full-contour restorations in 2009. Currently, we know flexural strength drops from the original 1,000+ MPa to 600 to 650+ MPa. What we do not know yet is if the fracture toughness (ability to resist crack propagation) will be affected adversely by the changes needed to gain translucence. Clinically, there may be more chance of breakage in high-stress situations such as heavy bruxing/clenching and multiunit posterior prostheses. However, for single-unit crowns in nonbruxing patients, 600+ MPa should provide adequate strength, based on the clinical success of many posterior cases of lithium disilicate (IPS e.max [Ivoclar Vivadent]) with its flexural strength of about 300 to 350+ MPa.

Rella Christensen, PhD

Q: What are the indications and contraindications for translucent zirconia?

A: Indications are need and desire for optimal aesthetics where strength beyond conventional ceramics is needed. Although not yet proven clinically, contraindications may be posterior restorations in the high-stress situations mentioned above. The original less translucent zirconia formulations (at 1,000+ MPa) may be a better choice for these situations. In the past, in-office milling with its single-patient appointment has not been possible with zirconia due to the lengthy post-mill sintering (8+ hours) necessary for optimal strength. This contraindication is eliminated with the introduction of Pavati Z40.1 blocks for in-office milling from CAD/CAM Research Institute. Blocks of this material are post-mill sintered in 10 minutes using the new inFire HTC superspeed high-temperature furnace from Sirona, which will be available to dentists for about $10,000.

Q: Do the translucent zirconias require changes in the cementation procedures?

A: No. Different manufacturers' directions may vary, but right now, cleaning of the restoration after try-in is still accomplished with light sandblasting or Ivoclean (Ivoclar Vivadent), and cementation can include use of primers like Monobond Plus (Ivoclar Vivadent) or Z-Prime (Bisco Dental Products), and cementation with a resin-modified glass ionmer or resin cement.

Q: Will translucent zirconia restorations cost more from my lab? Are there cautions to consider when selecting a translucent zirconia brand?

A: Right now costs are around $100 per unit nationally.

As far as cautions are concerned, many dentists and laboratory technicians do not know that zirconia formulations from different sources differ. They can differ in particle size, particle size distribution, additives such as oxide and binders, purity, porosity, and production methods. These differences can affect clinical durability and safety of the product. Dentists should ask their labs to include the brand and company name of the zirconia used for their restorations, and this information should be entered into the patient's record for legal and ethical traceability. This can be essential in case of patient hypersensitivity or unexpected incidents in a restoration's performance. We recommend using materials from known dental companies with established reputations, even though costs may be a little higher.

TRAC Research is conducting a controlled clinical trial to follow the clinical performance of several translucent zirconia brands in single-unit, full-contour monolithic molar restorations. Brand names and companies of the materials to be studied are: BruxZir Anterior, cubeX^2 (Dental Arts Laboratories), Katana STML (Kuraray/Noritake), Pavati Z40.1, and Zenostar LT (Ivoclar Vivadent). We will report yearly on these products as the study progresses.

Another caution involves use of glazes. Our clinical studies show the current glazes for zirconia and lithium disilicate are not long lasting. As they degrade, they form very rough borders around occlusal contacts that can accelerate damage to opposing dentition. We suggest use of polishing instead of glazing, or restricting glaze to nonoccluding smooth surfaces.

Q: What are future expectations for zirconia?

A: At the rate zirconia technology is now developing, it appears that we are entering the "age of zirconia" in dentistry for both anterior and posterior restorations.

Dr. Christensen leads TRAC Research Laboratory, devoted to clinical research in oral microbiology and dental restorative concepts, which is part of the nonprofit educational Clinicians Report Foundation (formerly CRA), which she directed for 27 years. She can be reached at rella@tracresearch.org.