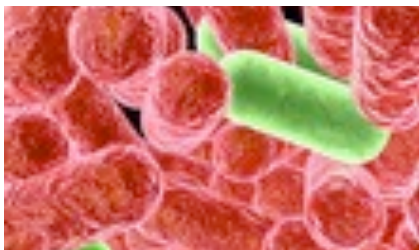


FotoSanNewsletter



DEAR DENTIST

After reading this newsletter we encourage you to contemplate the following questions:

1

EFFICIENCY IN PERIO

Do you know of any other treatment modality that following less than 60 seconds treatment per pocket as an adjunction to SRP has the same dramatic clinical and bacteriological effects?

2

EFFICIENCY IN ENDO

Do you know of any other disinfectant method that can increase bacterial killing by a factor 7 in just 30 seconds as an adjunction to rinsing with 6% NaOCl?

3

WHAT WILL YOU DO ABOUT IT?

Do You wish to wait for more studies to be published?

OR

Do You want to see the results for yourself in your practice?

Light Activated Disinfection (LAD)

What is the status right now?

Light Activated Disinfection (LAD) will probably be one of the most promising new technologies in dentistry in the next decade. LAD is a variation of the broader technology PDT - Photo Dynamic Therapy, which has been used in medicine the last 20 years or more. LAD has also been known for several years, it is however only due to improved technology that it is now possible to apply the concept successfully in clinical practice. Improved hardware makes it possible to treat patients in seconds or a few minutes. In this issue we will make a status of the clinical applications.

LAD in periodontology

The FotoSan system is currently used in a number of scientific studies in many different countries. One of the first countries to embrace the system is Italy. The 30th of October at the Sapienza University in Rome a scientific seminar was held on Light Activated Disinfection (see program). Professor Piloni and Dr. Mongardini are almost through phase II of their clinical protocol. Phase I was a proof-

of-principle clinical study to verify: 1) which application is more effective and 2) what dose (time) is efficient. The study was made as a split mouth design with baseline microbiological testing and retesting 1 week after therapy. Control was SRP alone, the test group received SRP+FotoSan. The results showed that treatment inside the pockets is more efficient than treatment from outside, even though quite a lot of power is lost

Università La Sapienza - ROMA

PROGRAM FOTOSAN DAY 30TH OCTOBER, 2010

THE PHOTODYNAMIC THERAPY IN DENTISTRY: LIGHT ACTIVATED DISINFECTION.

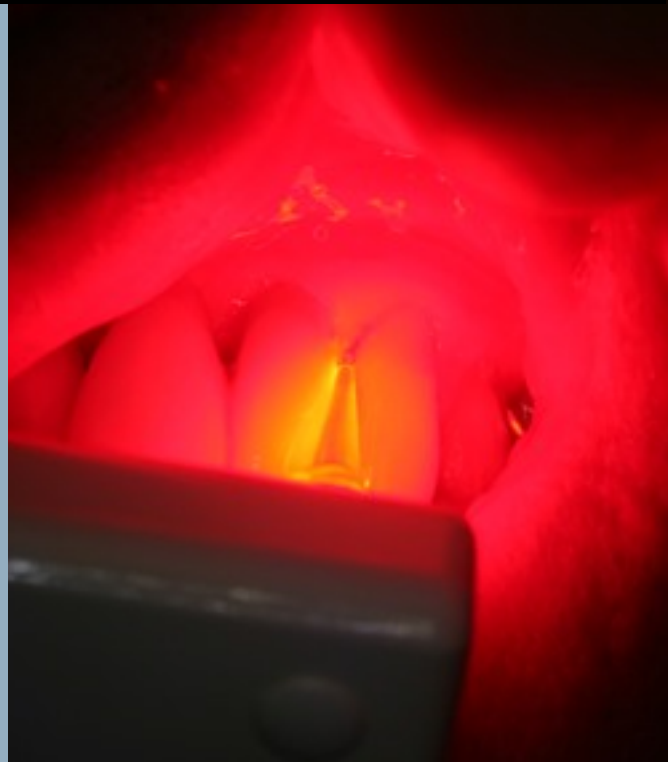
- 8.45 Registration of participants
- 9.00: Presentation of the seminar.
 - Prof. A. Polimeni (Direttore Dipartimento di Scienze Odontostomatologiche e Maxillo-Facciali).
 - Prof. M. De Luca (Cattedra Parodontologia Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria e Corso di Laurea in Igiene Dentale).
- 9.30 New diagnostics to better understand the periodontal disease.
 - Prof. A. Piloni (Cattedra Parodontologia Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria e Corso di Laurea in Igiene Dentale).
- 10.15 Local chemical infection control in periodontology
 - Dr. F. Dominici (Cattedra Parodontologia Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria e Corso di Laurea in Igiene Dentale).
- 11.00 Coffee Break and visit of the stands
- 11.30 The Photodynamic therapy as an adjunctive tool in non-surgical periodontal therapy
 - Dr. C. Mongardini (Cattedra Parodontologia Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria e Corso di Laurea in Igiene Dentale).
- 12.15 The Photodynamic therapy in endodontics.
 - Prof. G. Gambarini and Prof. G. Plotino (Cattedra Endodonzia Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria e Corso di Laurea in Igiene Dentale).
- 13:00 Discussion and Closing Remarks.

FOTOSAN APPLICATION

THE SECRETS BEHIND THE EXTRAORDINARY RESULTS ARE THAT FOTOSAN HAS:

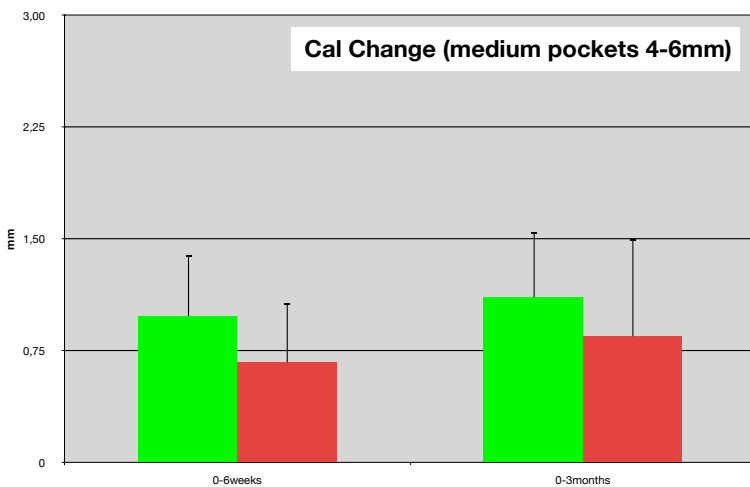
-the highest possible power
-a unique perio tip with sideways transmission of light
- fotosensitizer as a gel for better adherence
-vibration of the tip to increase interaction between photosensitizer and bacteria

Dr Jimmie Kert MD



when the thinner tip for pockets is used. For this phase I study the endo tip was used. Later, CMS has later

patients out of a total of 40. Final results are expected in 1. quarter of 2011.



■ Test
■ Control

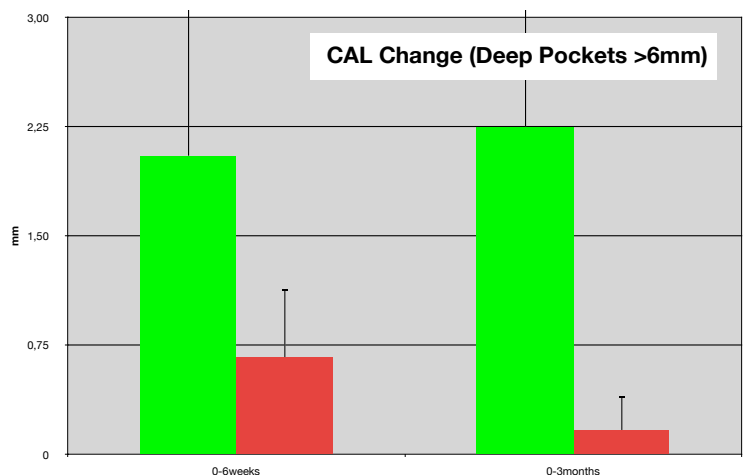
developed a perio-tip that emits 4 times more power into the pocket.

The phase II study is also a split mouth design where SRP alone and SRP+ FotoSan is compared. Patients are treated once, then evaluated after 6 weeks and 12 weeks clinically and bacteriologically.

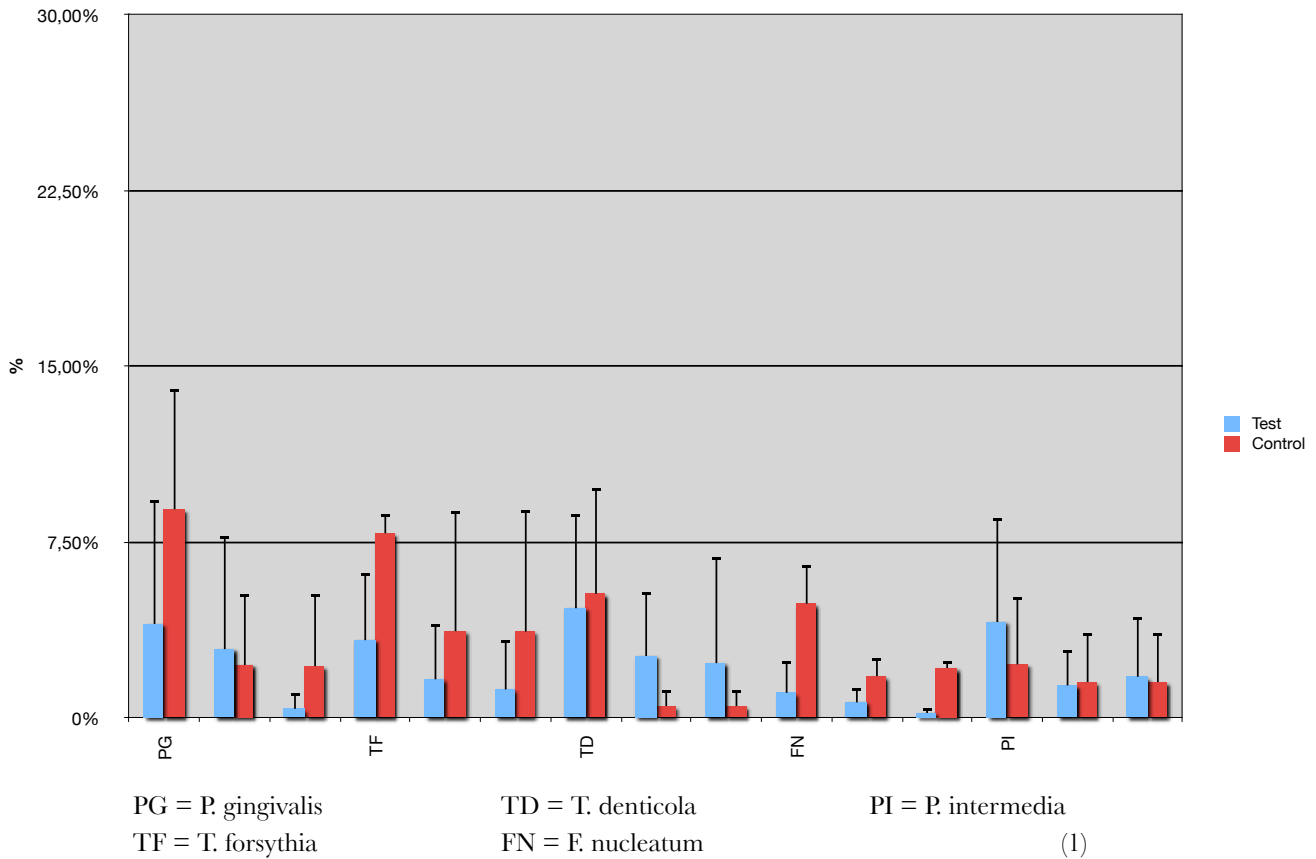
The results shown are from the phase II study. We see an increase in clinical attachment level (CAL) in the medium pockets. For the deeper pockets there is a much more significant difference between the FotoSan treated (+SRP) and the control (SRP) on CAL level. It should be noted that these results are preliminary - specifically on 25

Bleeding on probing (BOP) follows the same pattern with a significant decrease in the FotoSan treated pockets. For all results it is indeed very interesting - not to say surprising - that the results after FotoSan treatment is better 3 months after treatment compared to 6 weeks after treatment. For the control pockets the positive effect from SRP seem to level out or fall back after the 6 weeks mark.

The same very interesting result can be seen for the bacteriological findings. There is some reduction of the relative quantity of pathogens in the SRP pockets, but the effect levels out after 6 weeks. For the FotoSan treated pockets, on the contrary, the pattern is a further reduction of the relative portion of pathogens from week 6 to week 12.



Relative proportion Single Pathogens



Remember that the treated pockets only receive one single treatment. Furthermore since only a few pockets are treated with FotoSan, there remains a reservoir of pathogens in untreated pockets, which means, that in a clinical situation where all deeper pockets are treated, the results would be even better.

Conclusion:

Preliminary clinical results are better than expected compared to previous clinical studies on PAD/PACT, although in line with empiric findings from more than a thousand dentists using FotoSan.

What could be the reason for that?

There are several possible explanations why results with FotoSan now are better than previously described in the literature (2) for other PAD systems. In this meta-analysis by Azarpazhooh he included clinical studies using diode lasers on 660 nm and as photosensitizer phenothiazine chloride (4 out of 5) or methylene blue. More importantly the out-put power of the light sources (lasers) were from 30 to 150 mW. Treatment times were around 10 s per site, just as for FotoSan.

So why the difference in clinical results?

1. First of all the FotoSan light is 10 to 50 times more powerful than the lasers used in above mentioned analysis. When taking drugs - antibiotics or painkillers - if you only prescribe a dosage of 5% of the recommended would you expect success? No, of

course not. With a light activated therapy it is exactly the same. The amount of light energy applied is the dosage. Insufficient dosage gives of course dissatisfactory results!

2. The FotoSan system utilizes a perio-tip specifically designed to emit light also sideways in the distal 5 mm.
3. The FotoSan system uses the photosensitizer as a gel making it easier to retain the photosensitizer in the pocket during treatment.
4. The FotoSan system uses as the only system a vibrating tip. The increased micro circulation around the tip in the pocket and the root canal increases the chance of a contact between the photosensitizer and the bacteria.

Comments on terminology:

PDT means **Photo Dynamic Therapy** and is the broad expression for light activating a chemical (or pharmaceutical). Used in dermatology, for cancer treatment and other areas of medicine.

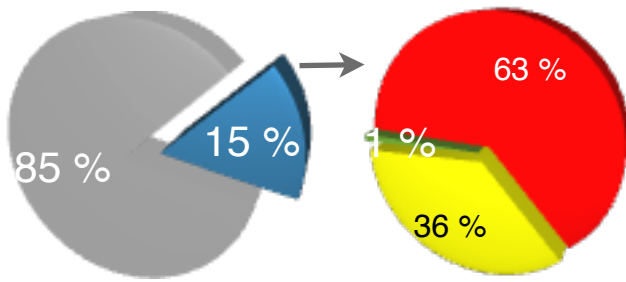
PACT stands for **Photo Dynamic Antimicrobial Chemo Therapy**.

PAD stands for **Photo Activated Disinfection**.

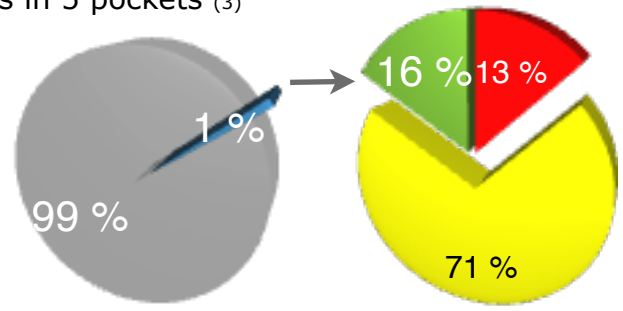
LAD stands for **Light Activated Disinfection**.

PACT, PAD and LAD are all describing the same therapy, used more or less arbitrarily by the individual author.

CASE: 56 year old man with chronic periodontitis in 5 pockets (3)



June 17: PD 6-7 mm. Bleeding on probing (BOP) in all 5 pockets. Baseline microbiology: 15% pathogen species out of total. Of the pathogens 63% is red complexes, yellow 36% and green 1%.
Treatment: SRP and FotoSan.



July 16: PD 4-5 mm. No bleeding on probing (BOP) in any pocket. Microbiology: 1% pathogen species out of total. Of the pathogens just 13% is red complexes, yellow 71% and green 16%.
Conclusion: Obvious clinical improvement supported by a clear shift in the microbiological flora.

Status: What's available as adjunctive therapy to SRP?

SRP is undisputedly the first step in any periodontitis regime. But what comes next? Because as important as SRP is, scientists and companies are constantly in search for add-on therapies. This of course signifies that SRP as a stand-alone treatment is not enough.

FotoSan (LAD). The principle is a photochemical reaction between a photosensitizer (in this case: toluidine blue O (TBO)) and a light source emitting a specific spectrum of light (in this case: maximum at 630 nm +/-). First step is: The TBO bonds to the microorganisms. Second step: The TBO absorbs energy from the red light, releases it again to oxygen molecules, that are changes from O_2 to active oxygen (so called ROS: reactive oxygen specimens). ROS kills the microorganisms by destroying the membrane and cellular structures. ROS can furthermore destroy non-human extracellular structures such as the polysaccharides in biofilm.

The advantages are plenty:

1. Instant effect
2. No risk of development of resistance
3. No side-effects - local or systemic
4. Effective on all microorganisms (see insert on p 6)

The instant effect means that the TBO gel only needs to be in the pocket less than 1 minute.

Surgical laser. The surgical laser is used with water-cooling in the pocket. Just around the tip of the light guide is so hot that the bacteria are killed. The down-

side of this therapy is it is technique sensitive, as tissue damage will occur if the laser fiber optic tip touches tissue. The treatment is also quite time consuming the tip must be moved circumferentially around the tooth in layers of one mm. For what this therapy really is about - a thin light guide emitting heat, 30-50,000 euros seems far too expensive. If you further add to the extensive security measures you have to deal with in the practice, such as security lock on doors, warning lights etc, the surgical laser will never become a main-stream option.

Systemic antibiotics. Systemic antibiotic treatment plays a role in the treatment of periodontitis. The big question is however when is it truly indicated, considering side-effects and the risk of creating multi resistance bacteria. Generally speaking, the better local options, the less indication for systemic antibiotics.

Chlorhexidine gel. Several studies (for example 4,5) show that 1-2 % chlorhexidine gel has no significant clinical effect. This is probably because the half time of chlorhexidine effect in the pocket is in the magnitude of 1 minute, and chlorhexidine requires around 5 minutes for its bactericidal effect. A new study (5) however shows a marginal positive effect on PD, but not on bleeding and bacteriological flora after 6 months. In this study chlorhexidine was administered in a newly formulated xanthane gel.

Local antibiotics. A few years ago Elyzol, a metronidazole gel, was first choice treatment. However when it showed (6) that a therapeutically efficient level

	light activated disinfection	hard-laser (surgical laser)	systemic antibiotics	chlorhexidine gel	local antibiotics
principle	photo chemical reaction	heating	pharmacological	chemical	pharmacological
limitations	1. photosensitizer to reach bacteria 2. light to reach photosensitizer	1. technique sensitive. Risk of heat damage 2. tip of light guide close to bacteria to be effective 3. very high price! 4. special safety installations in dental practice	1. difficult to get therapeutical concentration where it is needed 2. can only be repeated with care	1. doubtful clinical effect 2. gel to be in contact with bacteria 3. gel washed out in practice before effect	1. application time consuming/ technique sensitive 2. expensive 3. can only be repeated with care
onset	instant	instant	hours	5 minutes +	hours
side effects/ damages	none	risks of heat damages	1. gastro-intestinal discomfort 2. allergic reactions 3. risk of developing resistant bacteria	risk of discolorations when used over time	1. allergic reactions 2. risk of developing resistant bacteria
strong points	1. can be repeated as often as needed 2. instant effect 3. no super bug risk!	1. instant effect 2. no super bug risk!	1. easy - just a prescription		

of antibiotics is only present in the pocket 24 hours +/-, it was quickly abandoned. In recent years new slow release delivery systems have been developed, distributing antibiotics in the pocket up until 9-10 days. There are several concepts, however all are quite expensive and time consuming to place.

Conclusion: Laser has been around for 20+ years but never really has become a mainstream alternative for periodontitis. The idea of an instant bactericidal effect is however tempting, but it is a bit risky and a very expensive way to kill bacteria.

Light activated disinfection now offers the same advantage, but at low cost, at no risk, and side effects or long term development of super bugs!

The big conceptual difference to antibiotics - systemic or locally - is further that the bactericidal effect is immediate. Moreover you can in a way decide how "sterile" you want the pocket, it is only a question of dosage (how many seconds you light). "Sterility" is however not the target, as right after you end the treatment new bacteria will colonize the pocket - but you have given the "good" bacteria a head start. And this is the fundamentally difference between old

fashioned antibiotic treatment and LAD. When you administer for example local antibiotics they will kill bacteria in the pocket for a number of days with decreasing efficiency as the concentration falls. When therapeutic concentration is no longer sustainable the drug will still kill some of the good guys, but not necessarily the pathogens. If that happens what you do is giving the bad guys a head start!

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LAD in endodontics

We started applying the LAD principle in endodontics like so many others. It is an obvious choice, as it is more simple in the root canal: Bugs are just not wanted! Schlafer et al (6) showed that a high (approx. 97%) reduction of a very high bacterial load in extracted teeth after 30 s LAD. He also showed a clear dose-response relationship. For example after 30 s irradiation only 70% of *C. albicans* was killed, but after 120 s 100% was! Very recent results from Baylor University (7) with FotoSan delivers new surprising insight in the possibilities with LAD. The study was made on extracted teeth inoculated with *E. Faecalis* and incubated for 2 weeks. One group was rinsed with 6% NaOCl and another rinsed with 6% NaOCl plus received 30 s of FotoSan treatment. In the 6% NaOCl rinsed plus FotoSan treated group the killing of bacteria was 7 times **higher** than in the rinsed only group ($p < 0,005$).

Who would have believed that?

We are used to believe that a very potent treatment also is potentially harmful or has side-effects. This study shows in an elegant way the potential in LAD. A 6% NaOCl is certainly not considered harmless - you must protect gingiva and be careful where you use it. And yet it leaves bacteria in the canal, that can be killed only with LAD, which in contrast is completely harmless to other cells than microorganisms.

What can be concluded from the Schlafer and Baylor studies with FotoSan?

Many dentists already use LAD as a standard root canal disinfection method, but can we guarantee that it is always sufficient and you will never again experience an endodontic failure? No, of course not. A good clinical study on this would be nice, but would not really change the situation. There will never be a guarantee against endodontic failure. However understanding the principle of dosages versus action behind LAD will help you getting there a long way.

Practical tips on FotoSan treatments

The standard treatment is 30 s in the canal based partly on Schlafers work, partly on empiric experience and supported by the Baylor study.

However allowing a buffer zone for success we have made the following guidelines:

1. If the endo-tip does not get approx. 2/3 into the canal, then repeat the treatment.
2. In case of clinical signs of infection, then repeat the treatment.
3. If there is an apical clearing on the x-ray, treat also 10 s using the blunt tip on gingiva at level of apex.

DID YOU KNOW:

- ◆ That LAD is used to disinfect donor blood?
- ◆ That some bacteria contains an intrinsic photosensitizer so exposure to light itself is enough to kill them?

LASER LAD VS. LED LAD

WHAT IS THE DIFFERENCE?

The short answer is that there is none !

From a photochemical point of view all light is equally efficient as long as it has the proper wavelength (color). The difference in wavelengths between LED and laser is that while laser is monochromatic (i.e all light same wavelength) LED light spreads over 10-15 nm. However as the absorption spectrum of the photosensitizer typically has a much wider spread it has no practical significance. The only true difference is that laser light is unique in the sense that it is coherent, which means that all light waves are in phase. This unique feature makes it possible to use laser light as a surgical tool as one can focus the light in one point. This however, also makes laser light dangerous as relative low intensity laser light can damage the retina. This makes a practical limit to how powerful a laser you can use for PAD/LAD purpose.

In CMS Dental we have manufactured low level lasers for more than 20 years. (P-Laser, DioBeam etc).Our book "Clinical Laser Therapy" (from 1990) was the first textbook on low level laser applications, so we are in CMS Dental by no means negative about lasers.

However when it comes to light activated disinfection, a laser source is simply just not as efficient as a modern LED diode. That is because we can use much more powerful LED diodes, compared to laser diodes.

A laser LAD system will also typically use a very thin light guide to apply the light. This is not necessarily an advantage as the maybe 0.2 mm light guide only emits light at the tip.

For the FotoSan system we have chosen a tip with a diameter of 1 mm that emits light sideways - we do not want any room for error, just get it in and light it!

Q & A **These are typical questions with answers**

-
- Does light activated disinfection also work on anaerobic bacteria?*** YES, LAD works equally on aerobic and anaerobic bacteria. There is a difference on the speed of action on Gram-positive and Gram-negative bacteria - fastest on Gram-positive. That is because Gram-negative has an outer membrane for further protection, which has to be destroyed first. Anaerobic bacteria may be either Gram-pos or Gram-neg. What the question probably really means, is whether anaerobic bacteria can be destroyed as the LAD process requires oxygen. The answer is again YES. The anaerobic bacteria hide in a biofilm, but because of the scaling before the FotoSan treatment, the biofilm is disrupted. However more importantly the active oxygen (ROS) destroys the polysaccharides in the biofilm. It's cut into pieces exposing the bacteria. Remember also that the FotoSan Agent you inject into the pocket contains oxygen.
-
- Why does the LAD not harm human cells?*** Toluidine blue does not bond to intact human cells. The reactive oxygen specimens (ROS) created in the process, have an extremely short life time (nano seconds). As the ROS are created close to the target i.e. the bacteria are destroyed immediately.
-
- Why are only pathogen bacteria killed?*** Well, it is not the case. All bacteria are killed - at variable speed - however the "good" bacteria will get a head start in recolonizing the pocket. It is a race between the good and bad bacteria, and the good will take over - after all they are so more abundant. Compare to bacteriological results in article on page 3 - there are less bad bacteria in week 12 than in week 6 - even after one single FotoSan treatment.
-
- What about the bacteria that are hiding in the tubuli. Is a retreatment after 2-3 weeks a good idea?*** Theoretical yes, however in practice it is apparently not necessary, again with reference to bacteriological results on p 3.
-
- What about when the root canal is curved, does the light get all the way to apex?*** The canal is filled with fluid, so the canal itself will work as a light guide. To be sure to get enough light energy we recommend to give an extra 30 s if the tip does not go approximately 2/3 into the canal.
-
- Can you treat directly on an open wound? And when bleeding?*** Yes, you can do that. Several dentists have noticed that there is a hemostatic effect of the treatment. That can be explained by the interaction between the reactive oxygen and blood proteins. Bleeding will however dilute the LAD effect somewhat.
-
- Can I purchase the FotoSan Agent and use with another light?*** In principle yes, if the other light has an emission spectrum with a maximum around 630 nm. However, if the light is not as powerful as the FotoSan light you will have to compensate by using longer treatment time. Remember that it is the emitted energy, i.e. output power x time that is important. So half the output power means double treatment time.
-

Further Q & A's can be found on www.cmsdental.com

Other applications for Light Activated Disinfection

Application	Status
Pericoronitis	A lot of empirical experience indicating an immediate effect that is noticeable for the patient
Herpes simplex, aphtae	A lot of empirical experience indicating an immediate effect that is noticeable for the patient
C. albicans	A lot of empirical experience indicating an immediate effect that is noticeable for the patient
Periodontal surgery	It seems logical to secure best possible antibacterial status in all cases of surgery, this being osseo regeneration, membranes, flap surgery etc. Next step should be to make controlled clinical studies on this indication
Dry socket	Some empirical experience indicate a positive effect
Periimplantitis	Several empirical experience indicate positive effect. A large controlled blinded multi-center study is ongoing with FotoSan

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