

# Photodisinfection

## and its role in the management of chronic periodontitis

### A CASE REPORT

By Sarah Holslag



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The science of photodisinfection has a fascinating history. Literature dates back to 1500 BC describing therapy involving the placement of certain kinds of seeds on the skin which were then exposed to sunlight. These seeds contained a psoralen compound, which has since been shown to be a photosensitizing compound. Since that time, there are numerous conditions which have been shown to benefit from the therapeutic effects of lights such as psoriasis and newborn jaundice. In the early 1990's, it was found that photosensitisers could be used in conjunction with light to kill microorganisms, and indeed bacteria, yeasts and viruses can be inactivated in this way. Cationic sensitisers have been proven to kill both gram positive and gram negative bacteria in the presence of light.

The following is a case report utilizing photodisinfection with FotoSan for treatment of chronic periodontitis in an isolated periodontal defect.

#### Clinical options for treating periodontal disease

Traditionally, the treatment of periodontal diseases is composed of two distinct phases. The initial therapy, or nonsurgical phase, consists of procedures that are specifically designed to eliminate or control the various risk factors, which may contribute to chronic periodontitis. In this phase, hygienists provide oral hygiene instruction and periodic reinforcement; perform sub and supra-gingival debridement to remove microbial plaque and calculus; treat or remove local irritation factors such as decay, overhangs, ill-contoured crowns, and misaligned teeth; and recommend the use of various antimicrobial agents as adjuncts to the above treatments. If the initial therapy does not significantly improve the periodontal condition, periodontal surgery is considered in order to help resolve the disease process and/or assist in the correction of anatomic defects. A variety of surgical modalities may be appropriate in managing an individual patient.

In selecting periodontal treatment modalities, the dental professional should closely examine each

treatment alternative as a potential tool, and then decide which of these tools are best suited for a specific problem. A patient may benefit most from a "conservative" or nonsurgical approach in one quadrant, and a more "invasive" or surgical approach in another. From a clinical perspective, the critical determining factor is the treatment (or treatments) that will ultimately serve the patient best.

#### Nonsurgical versus surgical periodontal treatment

As evidenced in the periodontal literature, the beneficial effects of scaling and root planing in the treatment of chronic periodontitis have been extensively studied and validated. The reduction of clinical inflammation, microbial shifts to a less pathogenic flora, decreased probing depth of periodontal pockets, a gain in the clinical attachment, and a diminished progression of disease, are amongst these benefits.

Generally, clinical soft-tissue conditions improve following nonsurgical treatment. However, some intraoral sites do not respond to this initial therapy and may benefit from a surgical approach. Surgical access can facilitate mechanical instrumentation of the roots, reduce probing depths significantly, and even regenerate or reconstruct lost periodontal tissues. Clinical trials indicate that both surgical and nonsurgical therapy approaches can effectively stabilize clinical attachment levels<sup>1</sup>.

Each of these therapeutic modes has various advantages and drawbacks. A nonsurgical mechanical approach may be deemed more conservative. However, it may have limited efficacy in advanced diseased sites since it does not fully eliminate pathogenic bacteria from all infected areas; in particular, bacteria in deeper pockets and furcation areas<sup>2</sup>. Flap reflection is considered more invasive, but can be more effective in increasing the clinician's ability to debride the roots in these difficult areas<sup>2</sup>. Osseous surgery has been shown to produce an even greater reduction of probing depths, but on the other hand, results in more extensive degrees of recession<sup>3</sup>.

## Bacterial management in the periodontal pocket

The clinical manifestations that are identified as chronic periodontitis are the result of a complex chain of events that begins with the presence of pathogenic bacteria in the gingival sulcus, and in due course leads to a series of destructive host responses. The inflammatory response, which is elicited by the bacteria in the gingival tissue, is ultimately responsible for a progressive loss of the collagen attachment of the tooth to the underlying alveolar bone<sup>4</sup>. If left unchecked, this process can cause the tooth to loosen, and to eventually be lost.

At any given time, depending on its depth and extent, the periodontal pocket can harbor from 10<sup>7</sup> to almost 1,011 bacterial cells<sup>5</sup>. The success of traditional debridement procedures and/or antimicrobial agents in improving periodontal health is generally associated with the reduction in the levels of these anaerobic bacteria in the dental plaque<sup>6</sup>. Treatment has traditionally focused primarily on reducing the bacterial load in the periodontal tissues. This can be accomplished either through surgical or nonsurgical procedures, with the occasional adjunctive use of systemic and/or local antimicrobial agents in certain situations. Systemic antibiotics may be useful for those patients who fail to adequately respond to mechanical debridement procedures. Their use is limited, due to the emergence of resistant bacteria, the development of potential hypersensitivity reactions, and the occurrence of side effects<sup>7</sup>. The development of localized delivery systems that deposit highly concentrated doses of antibiotic and/or antimicrobial agents directly at the site of infection (in the periodontal pocket) have been shown to improve treatment efficacy, while at the same time decreasing side effects and limiting resistance.

More recently, a pathogen-specific antimicrobial that combines advanced Light Emitting Diode (LED) technology with a photosensitizing solution for the treatment of periodontal diseases has been introduced. FotoSan is a dual-action antimicrobial. This means that it not only kills gram-negative bacteria associated with periodontal disease, but also inactivates those endotoxins which are responsible for tissue destruction, thus greatly improving a patient's chances of healing<sup>8</sup>. FotoSan is also non-antibiotic, and as a result, does not carry any risks of promoting antibiotic resistance<sup>9</sup>. In clinical trials, those patients receiving FotoSan treatment in conjunction with scaling and root planing (SRP) experienced significant improvements over patients treated with SRP only: these benefits included shallower

pockets, increased clinical reattachment, and reduced bleeding<sup>10</sup>.

## The FotoSan treatment modality

The process of photodisinfection is the topical adaptation of photodynamic therapy (PDT). While photodisinfection (FotoSan) is new to dentistry, PDT has been used in various medical applications for more than 20 years. Photodynamic therapy is currently successfully being used for the treatment of some forms of cancer, macular degeneration, various dermatological applications, and plasma pooling disinfection. Photodisinfection was first adopted by Professor Michael Wilson (Eastman Dental Institute at the University College of London, England) in 1989. Today, there are several hundred peer-reviewed, preclinical studies written by Professor Wilson supporting this technology. Many of these focus on the effectiveness of photodynamic disinfection against various pathogens associated with periodontal diseases.

The underlying mechanism of photodisinfection is the targeting and the elimination of the bacteria most responsible for the progression of periodontal disease. Toluidine Blue O dye is gently injected (without the need for anesthetic) into the periodontal pocket. The dye binds to the lipopolysaccharides and lipids found on the cell walls of both gram-negative and gram-positive bacteria. Because of a difference in thickness of the peptidoglycan layer in their cell walls, gram-negative bacteria take up the methylene blue stain faster.

Meanwhile, the FotoSan Light Emitting Diode produces photons whose frequency matches that of the molecule of the toluidine blue dye. When the photons hit the dye molecules, they initiate the photodynamic chain of events. The oxygen molecules surrounding the dye are caused to lose an electron, and thus become free radicals. The free oxygen radicals are toxic to the bacterial cell walls and disrupt them, leading to the destruction of the bacteria.

FotoSan is a broad-spectrum antimicrobial system that targets subgingival bacteria as well as their virulence factors. Bacterial proteases, collagenases, and lipopolysaccharides are inactivated, resulting in a reduced host inflammatory reaction and a diminished destruction of the local periodontal tissues<sup>11</sup>.

Photodisinfection treatment is not meant to replace traditional mechanical scaling and root planing therapy but rather to complement it. A thorough debridement of the root is essential prior to the application of the photodisinfection process. In many cases, the combined therapies may result in a decreased need for surgical intervention, and can therefore

be considered a less invasive approach<sup>10</sup>. Photodisinfection may also be used during periodontal surgery to "disinfect" areas that may be difficult to instrument (such as furcations), particularly prior to regenerative procedures<sup>12,13</sup>.

## FotoSan treatment briefly described

FotoSan is a locally delivered antimicrobial which utilizes the technology of photodynamic disinfection or photodisinfection. Photodisinfection is a simple two step clinical procedure which causes cell destruction of targeted gram negative anaerobic microorganisms in a selected periodontal defect within 60 seconds.

The first step involves irrigation of the affected periodontal site with a photosensitizing solution (Toluidine Blue O) which selectively binds to the periodontal pathogens, while avoiding human tissue cells. The second step is illumination of this site with the light diffusing tip from a Light Emitting Diode of appropriate wavelength (630nm) for a period of 60 seconds. FotoSan photodisinfection has been shown to be effective against a wide range of perio-pathogens including *Porphyromonas gingivalis*, *Prevotella intermedia*, *Tannerella forsythia*, *Fusobacterium nucleatum* and *Actinobacillus actinomycetemcomitans*. Virulence factors associated with gram negative bacteria are also inactivated.

FotoSan treatment is relatively simple to administer. However, there are certain guidelines that must be respected for maximal efficacy. It is essential to flood the periodontal pocket to be treated with adequate photosensitizing solution. Too little solution will adversely affect the results. The required irradiation time is one minute and must be valued. Too little time may compromise the photodynamic process. Each periodontal pocket must be treated individually. Results are better if the treated pocket is not bleeding profusely. Excessive bleeding can dilute the photosensitizing solution. If a patient is bleeding extensively after mechanical therapy, it is advisable to bring the patient back within one to two weeks for photodisinfection. Some tissue sites respond considerably better when treated photodynamically more than once.

For patients who had not previously received periodontal therapy, the combined use of nonsurgical mechanical therapy and photodisinfection results in a significant reduction of the clinical signs of inflammation. This includes suppuration, bleeding on probing, oedema, and in the probing depths of pockets. For these patients, it was noted that while the probing depths decreased considerably,

soft-tissue recession was not significant.

For patients who had previously received periodontal therapy (surgical and/or nonsurgical), but were still exhibiting signs of soft tissue deterioration, the combined use of nonsurgical mechanical therapy and photodisinfection displayed a lesser reduction of probing depths but a very significant reduction of bleeding on probing. Since the lack of bleeding on probing is one the few reliable indicators of disease stability, a decrease in the percentage of bleeding sites is a desirable outcome even when the changes in probing depths remain minimal.

### Indications for the use of Photodisinfection

- ◆ With debridement for aggressive cases (instead of antibiotics)
- ◆ With debridement (when purulence

and generalized bleeding on probing are present)

- ◆ Refractory and recurrent cases of periodontitis
- ◆ Maintenance of difficult cases
- ◆ Disinfection of roots and furcation areas during regenerative surgery
- ◆ Disinfection of class II and III furcation involvement and deep vertical defects
- ◆ Peri-implantitis treatment

### Conclusion

FotoSan represents a novel and effective treatment system that can be used in conjunction with standard scaling and root planing procedures to improve treatment outcomes for patients with periodontal disease. Its nonsurgical profile improves the comfort of treatment and thus makes the process more attractive to patients. Its ease of use makes it suitable for hygienists.

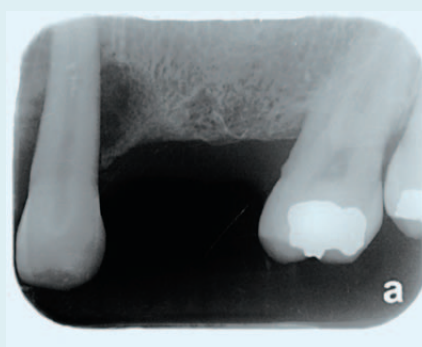
The role of photodisinfection in dental treatment is beginning to expand and should provide exciting new opportunities in oral healthcare. ◆

**Sarah Holslag** has worked in the dental industry for many years as a dental assistant and now as a dental hygienist. Sarah's hygiene career has included private and specialist practice, public health, corporate, continuing education and dental hygiene education. A graduate of TAFE SA in South Australia with an Advanced Diploma in Oral Health (Dental Hygiene), Sarah is currently embarking on the task of a Bachelor of Science in Dental Hygiene at Northern Arizona University, being the first Australian to be accepted into a bachelor program in the USA. Sarah currently practices clinical dental hygiene where she has gained extensive experience in the management of complex periodontal cases, aesthetics, implants and the clinical application of lasers in soft tissue management.

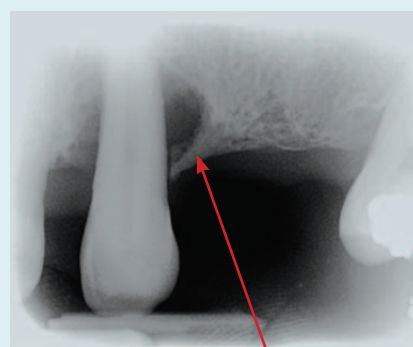
### THE CASE

A 49 year-old male with localised chronic periodontitis with an acute localised infection, presented for an emergency appointment to treat an acute periodontal infection with an isolated chronic 10 mm pocket with heavy bleeding on probing (BOP) and exudate on the distal of the maxillary left canine with a draining sinus present on the buccal attached mucosa. He was a non-smoker in poor general health with no known allergies. His medical history included: Chronic Urticaria, bronchial asthma, reflux, eczema, anxiety, hyperlipidaemia, hypertension. He is currently taking Eleuphrat ointment, elocon ointment, lipitor, lopid, losec, micardis, nasonex nasal spray, otocomb, temaze tablets, Ventolin, xanax. The impact of poly pharmacy were discussed as well as the link between perio and oral systemic conditions. The patient had been absent from the practice for a period of two years where he had previously been referred to a periodontist but had not attended.

Periodontal and radiographic examination revealed a chronic periodontal defect. The gingival tissue presented with localised oedema, erythema, mild cyanosis, rolled gingival margins and a 'thickened' soft tissue biotype with heavy BOP and exudate. The radiographic examination of the site revealed a vertical osseous defect with no evidence of a vertical fracture. The dentist recommended full mouth scaling and root planing, followed by local photodisinfection utilising FotoSan. Surgical treatment options were discussed with the patient, but he preferred to continue with a nonsurgical approach.



**Pre Treatment**



**Post Treatment**

Bone regeneration

On February 8th 2011 oral hygiene instruction and full mouth debridement were performed consisting of power-driven and manual scaling. It was recommended to schedule quadrant scaling including the photodisinfection treatment on the maxillary right canine one week later due to heavy bleeding in the distal and palatal aspect. Five days later, scaling and root planing and photodisinfection treatment with FotoSan was performed on the affected area. The buccal sinus was also treated supra gingivally with a blunt FotoSan tip.

Four months later, he re-presented for routine maintenance appointment, when it was noted that the pocket depth had reduced to 8mm with only light bleeding on probing in the treatment site. Clinical evaluation at this time revealed reduced oedema and erythema, the draining sinus healed and no exudate present. Oral hygiene instruction and full mouth debridement were repeated, again consisting of power-driven and manual scaling and root planing, followed immediately by a second photodisinfection treatment.

By August 22nd 2011, the pocket depth

had not reduced any further. Clinical examination indicated an absence of oedema and erythema, bleeding on probing, exudate, pain and overall improved gingival appearance. The dentist recommended continuing with a nonsurgical regime, although without precluding possible surgical intervention in the future.

The periodontal status of this patient had previously shown no apparent improvement over time despite regularly scheduled maintenance appointments. A combined treatment of scaling and root planing and photodisinfection was suggested as an attempt to reduce or eliminate residual periodontal pathogens in the affected site and so avoid the need for surgical intervention.

The patient reported no discomfort or adverse effects with FotoSan treatment. Although the precise aetiology of this periodontal lesion remains unknown, the adjunctive photodisinfection appears to have been instrumental in reducing the PD from 10 mm to 7 mm with elimination of bleeding on probing and pain.