Treatment of Acute Periodontal Abscesses Using the Biofilm Decontamination Approach: A Case Report Study

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The aim of this preliminary study was to show the treatment effect of the biofilm decontamination approach on acute periodontal abscesses. Clinical cases showing acute periodontitis were treated using an oral tissue decontaminant material that contains a concentrated aqueous mixture of hydroxybenzenesulfonic and hydroxymethoxybenzene acids and sulfuric acid. The material was positioned into the pocket on the root surface and left in the site for 30 seconds. No instrumentation was performed before the treatment. No systemic or local antibiotics were used in any of the cases. A questionnaire was used for each patient to record the pain/discomfort felt when the material was administered. All of the treated cases healed well and very rapidly. The infections were quickly resolved without complications, and the pockets associated with marginal tissue recession were also reduced. The momentary pain upon introduction of the material was generally well tolerated in the nonsurgically treated cases, and it completely disappeared after a few seconds. The biofilm decontamination approach seems to be a very promising technique for the treatment of acute periodontal abscess. The local application of this material avoids the use of systemic or local antibiotics.
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A variety of human infections, such as otitis media, musculoskeletal infections, necrotizing fasciitis, biliary tract infections, osteomyelitis, bacterial prostatitis, native valve endocarditis, and cystic fibrosis pneumonia, involve an ecologic system called biofilm. Dental caries and periodontitis are infectious diseases caused by a plaque biofilm.[1] A biofilm is any group of microorganisms that are embedded within a self-produced matrix of extracellular polymeric substance (EPS) composed of extracellular DNA, proteins, and polysaccharides. Biofilms may form on living or nonliving surfaces and can be prevalent in natural, industrial, and hospital settings.[1] The microbial cells growing in a biofilm are physiologically distinct from planktonic cells of the same organism, which, by contrast, are single cells that float or swim in a liquid medium.

A plaque biofilm can be found on the surface of all the hard and soft tissues of the mouth. The biofilm starts to form when a microorganism attaches to a hard surface in a wet environment, such as a tooth, through a chemical interaction. The microbe starts to replicate and at the same time recruits other microbes in the area to attach to the same surface. The microbes continue to replicate and at some critical point they start to jointly secrete a polysaccharide material referred to as the

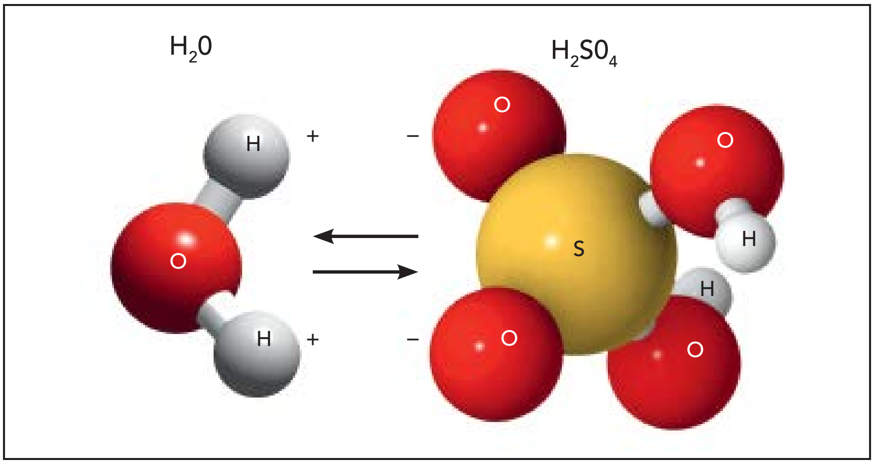

Fig 1 *Interaction between sulfate group and water molecules. A sulfate group has a strong negative surface charge, while water molecules show a positively charged surface on one side. A sulfate group tends to match up its large negative surface to the many positive surfaces of water molecules (hydrogen bond).*

extracellular matrix. The matrix develops as an irregularly shaped layer of an aqueous polysaccharide gel. The matrix is populated by several species of microbes, which grow in clusters or colonies within the gel. Bacteria that live in the biofilm can be active, adjusting their metabolism to function well in the matrix. Sometimes they enter into a type of hibernation, a persister state, in which they become resistant to the actions of many antimicrobial agents; in fact, the metabolic pathways of the bacteria must be active for these antimicrobial agents to have an effect on them.[2]

The treatment of periodontal disease is commonly based on oral hygiene and root debridement. Local and systemic administration of antibiotics may be used as adjunctive therapy for reducing or eliminating microbes because of the infectious nature of periodontitis.

There are different localized therapy approaches, such as mouthrinses or subgingival irrigations or controlled delivery systems, but their efficacy is questionable. Irrigation solutions with nonsubstantive agents initially reach the active concentration in the target pocket, but the flow of the crevicular fluid rapidly cleans the medication from the action site.[3] On the other hand, substantive drugs such as chlorhexidine and tetracycline have effective antibacterial activity but limitations on reservoir volume curtail the duration of antimicrobial effects.[4] Controlled drug delivery systems have been developed to reach the site of action (periodontal pockets), maintaining an effective concentration for a sufficient length of time to produce the desired effect.[4] Tetracycline fibers employed as a supplement to mechanical therapy in the treatment of periodontal pockets have yielded favorable outcomes with depression of periodontal pathogens, reduction of bleeding on probing, and increased probing attachment levels.[5,6] However, the market availability of that drug is currently limited.

Recent pharmacological research on the treatment of biofilm-induced diseases has shifted from the antimicrobial effect to the effects of substances that destroy the biofilm so that the bacteria cannot survive.

A sulfonic/sulfuric acid solution (HYBENX, EPIEN Medical) shows characteristics of contact desiccants because it contains concentrated blends of sulfonic/sulfuric acids, which have a strong affinity for water. In fact, these components (as liquid or gel) contain a concentrated aqueous mixture of hydroxybenzenesulfonic acid (37%) and hydroxymethoxybenzene acids (23%), sulfuric acid (28%), and water (12%). The hydroxybenzenes are keratolitic, while the sulfonate group and sulfuric acid are hygroscopic and denaturing. The liquid and the gel have the same concentrations. The chemical action is due to the interaction between the sulfate group and water molecules. In fact, the sulfate group has an internal polar structure, with the oxygen atoms on the outer surface of the group carrying a strong negative surface charge (Fig 1). The structure of water molecules also has significant polarity, which gives them a negatively charged surface on one side and a positively charged surface on the other (Fig 1). A sulfate group tends to match up its large negative surface to the many positive surfaces of water molecules. Water molecules become reversibly bound to a sulfate surface through an electrostatic interaction known as a hydrogen bond, where the positive charge on the surface of the hydrogen atoms of the water molecule is attracted to the negative charge of the surface of a group of oxygen atoms (Fig 1).[7]

Due to its chemical structure, the material is able to denature the biofilm matrix through a potent desiccating action. The desiccation of the biofilm is caused by the rapid subtraction of water from the matrix by sulfonic and sulfuric acids, which coagulates and shrinks the matrix and microbes. The biofilm material precipitates, contracts together, and separates from the root surface. This action facilitates the removal of dental plaque, allowing for the eradication of plaque microbes.[8]

The oral tissue decontaminant has been also used in the treatment of recurrent aphthous stomatitis (RAS), and a randomized controlled trial concluded that it safely and effectively reduces the painful symptoms of RAS.[9] This outcome is due to the material action that creates a protective layer of coagulated tissue debris on the ulcer surface, which reduces discomfort and pain for the patient.

The aim of this pilot study was to show the treatment effect of the biofilm decontamination approach on acute periodontal abscesses, avoiding the use of systemic or local antibiotics, through clinical case reports.

Case reports

Patients showing acute periodontitis were treated using the oral tissue decontaminant approved as a Class CE medical device by the Italian Ministry of Health (no. 483768) on February 7, 2012. All subjects were informed of the nature, potential risks, and benefits of their participation in the study. Patients provided written and signed informed consent in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Case 1

A 65-year old man, periodontally treated and maintained every 4 months for 23 years in a private practice (GPP) with good compliance and adequate plaque control, had recurring episodes of periodontitis that were treated by scaling and root planing with and without flap surgery.

After 24 years of maintenance, the patient came to the office showing an acute periodontal abscess at the mandibular second premolar with bleeding, pain, swelling, and a probing depth of 7 mm associated with moderate tooth mobility and impaired chewing function (Fig 2a). No mechanical instrumentation and no local anesthesia were performed. Approximately 0.5 ml of HYBENX was delivered from the tip of a syringe with blunt-tipped cannula, which was positioned intrasulcularly in the buccal site and left in the pocket for 30 seconds (Fig 2b). The material was removed after 1 minute by thoroughly irrigating the treated area with water. The patient reported a stinging sensation for a few seconds during the injection. After the removal of the material, a dehydration of the gingival surface occurred (Fig 2c). No local or systemic antibiotics were prescribed.

After 4 days, the patient reported improvement and decreased inflammation and said that the pain had disappeared completely.

After 16 days, the treated area appeared healthy, with no sign of marginal inflammation (Fig 2d). After 3 months it revealed 2 mm of pocket depth (Fig 2e). The patient then underwent supporting periodontal therapy (SPT).

Case 2

A 33-year old man was referred to a private practice (GPP) for an acute abscess, characterized by pus, swelling, bleeding, severe pain, and 15-mm probing depth at the maxillary left second molar. Severe localized bone loss was detected by periapical x-ray (Fig 3a). No instrumentation was performed and no local anesthesia was administered. An immediate intrasulcular injection of decontaminant material was given in the interdental palatal site

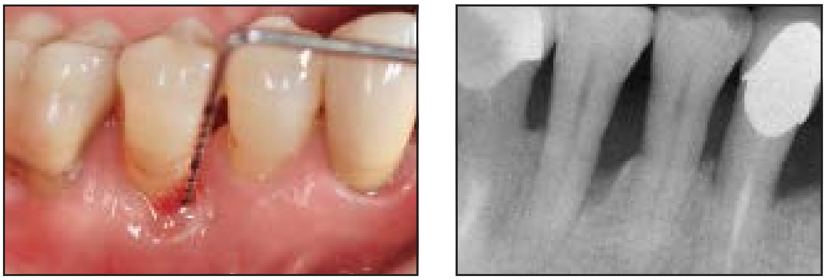

Fig 2a *Case 1. Clinical and radiographic views of an acute periodontal abscess on the mandibular second premolar with bleeding on probing (7 mm) associated with moderate tooth mobility and impaired chewing function.*

Fig 2b *Case 1. No mechanical instrumentation and no local anesthesia were performed. The decontaminant material (gel) was positioned in the buccal intrasulcular site using the syringe and left in the pocket for 30 seconds.*

Fig 2c *Case 1. An area of dehydration appeared in the gingival margin for a few minutes.*

Fig 2d *Case 1. The treated area was healthy after 16 days.*

Fig 2e *Case 1. After 3 months, the treated area was healthy and showed 2 mm of pocket depth.*

(Fig 3b). The patient reported pain for a few seconds during the injection. The material was removed after 30 seconds with copious water irrigation, and a white dehydrated area of superficial tissues developed. No systemic antibiotics were prescribed.

After 4 days, the patient reported improved conditions, with decreased inflammation. Edema and pain had almost disappeared. After 8 days, inflammation, swelling, and pain had disappeared with a marked reduction in probing depth to 5 mm (Fig 3c). After 16 days, the treated area showed a further reduction of probing depth (3 mm) with no signs of inflammation (Fig 3d). The patient underwent a periodontal treatment plan.

Case 3

A 56-year-old man was treated for chronic periodontitis and maintained every 6 months for 11 years in a private practice (GPP) with good compliance. Suddenly, the patient developed an acute periodontal abscess at a mandibular incisor associated with pain, swelling, and a probing depth of 6 mm. Periapical x-ray showed an infrabony defect (Fig 4a). The patient underwent the surgical procedure to resolve the infrabony defect. After local anesthesia, flap surgery was performed to treat the deep pocket, and the decontaminant gel was applied over the exposed root surface (Fig 4b). After 30 seconds, the material was removed and a delicate root planing was done with a sharp curette. The flap was then sutured (Fig 4c). The sutures were removed after 8 days. After 30 days, the deep defect was eliminated, associated with marginal recession and shallow pocket depth (Fig 4d).

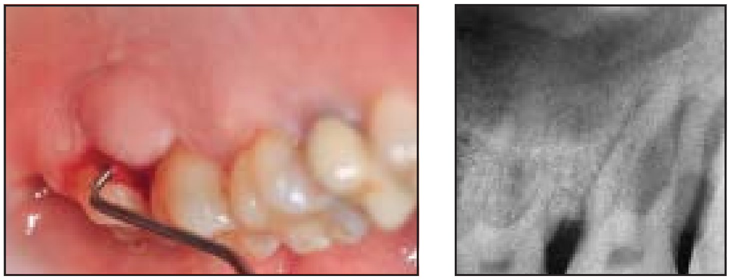

Fig 3a *Case 2. Acute periodontal abscess, pus, swelling, and bleeding on probing (15 mm) at the maxillary left second molar. Severe bone loss is revealed in the periapical radiograph.*

Fig 3b *Case 2. No instrumentation of the site and no local anesthesia were carried out, and an immediate intrasulcular positioning of the material (gel) was performed in the interdental palatal site using the syringe. No systemic antibiotics were prescribed.*

Fig 3c (left) *Case 2. After 8 days, inflammation, swelling, and pain had completely disappeared and there was a marked reduction in probing depth (5 mm).*

Fig 3d (right) *Case 2. After 30 days, the treated area showed a reduced pocket depth (3 mm) and absence of bleeding on probing.*

Fig 4a *Case 3. Clinical and radiographic views of an acute periodontal abscess at a mandibular central incisor.*

Fig 4b *Case 3. Flap surgery was performed to treat the deep pocket, and the tissue decontaminant (gel) was positioned over the exposed root surface.*

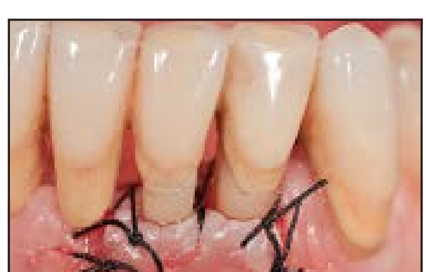

Fig 4c *Case 3. The material was removed after 1 minute and the flap was sutured.*

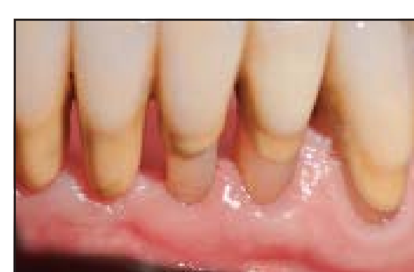

Fig 4d *Case 3. Healing after 1 month showing complete elimination of the defect.*

Fig 5a *Case 4. Periodontal abscess at the maxillary lateral incisor associated with 13 mm pocket depth.*

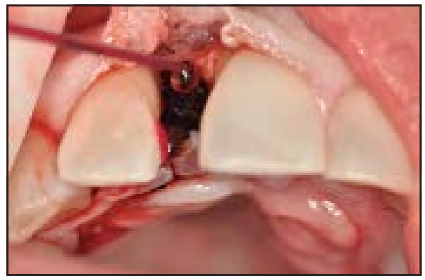

Fig 5b *Case 4. Flap surgery was performed and the tissue decontaminant (gel) was applied over the exposed root surface.*

Fig 5c *Case 4. The flap was sutured.*

Fig 5d *Case 4. After 14 days, the treated area appeared healthy.*

Fig 5e *Case 4. Clinical and radiographic views after 30 days showing the treated area associated with a shallow sulcus (2 mm) and initial bone remineralization (radiograph).*

Case 4

A 30-year-old female patient was referred to a private practice (GPP) for an acute abscess characterized by tooth migration, pus, swelling, severe pain, bleeding on probing, and 13 mm of pocket depth at the maxillary lateral second incisor. Severe bone loss was detected by periapical x-ray (Fig 5a). According to an antiblastic therapy protocol for a cerebral tumor, the patient was scheduled to begin a new phase of chemotherapy 3 days later. Since she had been advised not to take antibiotics prior to the chemotherapy, the oral tissue decontaminant was selected for the treatment of the severe abscess. Following local anesthesia, flap surgery was performed to treat the deep pocket and about 0.5 mL of the decontaminant gel was applied over the exposed root surface of the lateral incisor (Fig 5b). After 30 seconds the material was removed; the flap was then sutured (Fig 5c).

After 3 days, the patient reported improved conditions. Inflammation, swelling, and pain had completely disappeared. The improved condition allowed the start of antiblastic treatment, having avoided the use of antibiotics. No mechanical instrumentation was performed during the healing period, and after 14 days inflammation had disappeared (Fig 5d). After 1 month, the treated area appeared healthy, with a shallow probing depth (2 mm), and the periapical radiograph showed initial bone regeneration (Fig 5e). The patient then underwent a combined orthodontic and periodontal treatment plan.

Fig 6a *Case 5. Acute abscess, with pus, severe pain, bleeding on probing, and 12 mm of pocket depth at the maxillary left canine.*

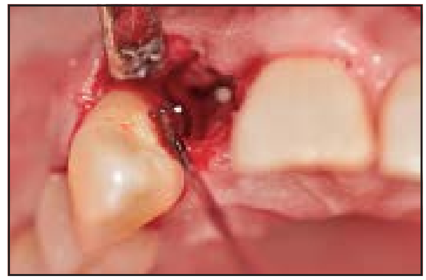

Fig 6b *Case 5. Flap surgery was performed and the decontaminant liquid was applied over the exposed root surface of the canine.*

Fig 6c *Case 5. Healing of the treated area after 20 days of oral decontaminant administration, with an evident tissue contraction.*

Table 1 Description of the treated clinical cases

Case	PD_0 (mm)	BoP_0	Rec_0 (mm)	Pain during decontaminant administration (VAS)	PD_1 (mm)	BoP_1	Rec_1 (mm)	Discomfort/ following (d)
1	7 mm	+	2.5	4	2	–	4	2
2	15 mm	+	3	5	3	–	0	3
3	9 mm	+	1	Anesthesia/flap	1.5	–	5	3
4	13 mm	+	0	Anesthesia/flap	2	–	3	3
5	12 mm	+	1	Anesthesia/flap	4	–	4	3

PD = pocket depth; BoP = bleeding on probing; Rec = gingival recession; VAS = visual analog scale.

Case 5

A 62-year-old woman was referred to a private practice (GPP) for the treatment of an acute abscess with pus, severe pain, bleeding on probing, and 12 mm of pocket depth at the maxillary left canine. Bone loss was also detected by periapical x-ray (Fig 6a). The patient was allergic to antibiotics; therefore, the oral tissue decontaminant was selected for the treatment of the acute lesion. Following local anesthesia, flap surgery was performed and the decontaminant liquid was applied over the exposed root surface of the canine (Fig 6b). After 30 seconds, the material was removed and the flap was sutured.

After 7 days, the patient reported improved conditions. Inflammation and pain had completely disappeared. No mechanical instrumentation was performed during the healing period. Twenty days after decontaminant administration, the treated area showed no signs of inflammation, with a consistent tissue retraction and a complete resolution of the periodontal abscess in absence of local or systemic antibiotic therapy (Fig 6c). After 1 month the patient underwent a periodontal treatment plan.

Pain and discomfort assessment

The patients, who received the material without anesthesia, were asked to grade their discomfort on a scale from 0 (no pain) to 10 (very painful). They reported a moderate pain (score 4 to 6) (Table 1). In addition, the patients were also asked to state the number of days in which they experienced discomfort following the treatment day. All patients reported that the discomfort disappeared after 2 to 3 days (Table 1).

Discussion

Many infectious diseases are caused by bacterial biofilm and not by planktonic germs, and these certainly include caries and periodontitis.[1]

It is well known that it is difficult for local and systemic antibiotics to reach, reduce, and eradicate bacteria because the presence of the biofilm creates a protective niche around them. Indeed, it has been proven that antiseptics are more effective if the biofilm has been broken down with manual or ultrasonic devices.[10,11]

Modern research has shifted from attacking the microbes directly with antiseptics or antibiotics to destroying the structure of the biofilm and thereby causing the death of the bacteria it contains. The rapid and immediate dehydration and coagulation of the biofilm and the subsequent death of the bacteria are caused by the chemical properties of the material in which the sulfuric and sulfonic groups with their strong negative charge exert a strong attraction on the water molecule of the biofilm matrix that has a positive surface charge due to the presence of hydrogen atoms. Phosphoric acid is commonly used as an etchant to prepare the tooth surface for various procedures. As regards dental safety, if HYBENX were used in the same way it would be a very ineffective etchant. It would remove biofilm, but it does not have sufficient acidity to prepare the enamel surface in the same way as phosphoric acid.

The antibacterial effect and safety of the oral decontaminant have been successfully documented in the treatment of oral aphthas where the denaturing of the ulcer surface led to rapid healing of the aphthous lesions as reported in a randomized study.[9]

On the basis of this knowledge, the present authors wanted to test the material in cases of acute periodontal abscesses. The lesions treated with this approach healed surprisingly well and very quickly in both the nonsurgical and surgical (where the material was applied directly to the exposed roots) cases. The infections were quickly resolved in all the cases without complications, and the pockets associated with marginal tissue recession were reduced. The residual marked recession of the gingival margin following the treatment occurred as a consequence of the healing of the acute abscesses that were associated with a severe tissue swelling. However, patients did not complain of dental hypersensitivity during the period that followed.

It is also important to note that no local anesthesia was administered in the patients treated without flap surgery. The momentary pain upon introduction of the material was generally well tolerated, and it completely disappeared after 2 to 3 days (Table 1).

However, the most important aspect of local application of the decontaminant material for the treatment of bacterial biofilm is that no systemic or local antibiotics were used in any of these cases. Avoiding the use of antibiotics in the treatment of periodontitis is an enormous step forward. It is widely accepted that the indiscriminate and repeated use of local antibiotics can lead to antimicrobial resistance that may be life-threatening for patients.[12]

In conclusion, biofilm dehydration seems to be a very promising technique for the treatment of acute periodontal abscess, avoiding the use of systemic or local antibiotics. It certainly merits further controlled and randomized studies for a full evaluation.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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