Ozone Dentistry

Miracle Ozone Dentistry --- A New Anti-Decay Dental Practice

by **Dr Julian Holmes**

(1-31-07)

Let me paint you a picture. Every Monday morning, dental practices over the world power up for a week's worth of drilling and filling, tooth removal, and reconstruction work. Queues of fearful patients, tearful children being comforted by anxious parents, people in considerable pain, line up outside the doors to their dental surgeries. Once inside, these patients are subjected to the traditional smells of oil of cloves, disinfectants, and the noises of the high pitch whine of the dental drill; the odd scream or two filters through the hushed, usually silent waiting room into the street outside. It is a sad fact of life that every dentist is trained that if there is an area of decay in your tooth, the only way to treat this is to drill the decay out or amputate it, and then place a filling that will have to be replaced at some stage.

For a small minority of patients, where their dental practices have chosen to invest in a new technology, the opposite happens almost every day. The queue is one of bright, cheerful adults and children; there are few smells to associate this practice with the traditional one down the road. The noise of the drill is seldom heard, and happy smiling faces emerge from the treatment room.

Since 1998 researchers, lead by Professor Edward Lynch from Queen's Dental Hospital and Belfast University, Ireland, have opened a radically and revolutionary way forward. The dental profession no longer has to destroy tooth tissue to eliminate bacteria. A simple 60 second (average treatment time) treatment with a device that delivers a burst of ozone will destroy all the bacteria that caused the infection and the decay. It destroys all the organic effluents that are produced by these bacteria; this is shown in Fig 1 opposite. The top data shows the spread of organic bio-molecules produced by an active carious lesion. The lower data shows the effect of 10 seconds of ozone; the profile now consists of a single main spike of acetate acid, and the other oxidation by-product is carbon dioxide. This H MNR research proved that ozone worked as a pharmaceutical approach to caries in-vitro. By effectively sterilising the lesion, minerals from the patients own saliva will re-enter the areas of mineral loss to harden them. Once hardened, it is more resistant to future bacterial attack and mineral loss.

There is in all our mouths a natural balance. Your tooth surface losses minerals into your saliva at certain times, usually just after you start to eat. These acidic conditions favour mineral loss. The normal acid/alkaline balance exists in the oral cavity. When bacteria attach themselves to a tooth surface, they set up a complex community of some 450 different bacterial types over a period of time. If patients skimp on using a tooth brush, or forget to use dental floss on a regular basis, these communities of bacteria evolve into one which produces large volumes of acids. These acids attack the tooth surface, dissolving out the minerals, leaving a hole or cavity. As this cavity now gives the bacterial colonies a degree of protection, tooth brushing cannot remove the bacteria and so the process of decay accelerates.

Yet decay is only an infection process that leads to the softening of the tooth, and the formation of a cavity, so could this infection be treated with, say, antibiotics? The bacteria that cause tooth decay are often found deep within the structure of the tooth, so their removal has to date only been by amputating the infected part of the tooth. Antibiotics and other pharmaceutical agents cannot penetrate deep enough through bacterial pellicle and tooth structure to eliminate acid niche environment. This teaching and technique is based on sound engineering principles that originate from the Victorians! Despite modern advances, there is no simple test that can be applied to a cavity to tell the dentist if they have removed all the infection! or enough tooth material! And if areas of infection are left behind, there is a good chance that the filling placed will fail at some time in the future.

In an attempt to prevent further infection and to restore the tooth to its original shape and function, a filling is then placed. Studies over the years have shown that fillings do not last very long, any where from 6 months to several years. But once a tooth has had part of it amputated, there is no going back. For each time the filling needs to be removed and replaced, there is a little less of the original tooth left and a larger filling. A point is reached where there is no option but to opt for expensive reconstruction work with advanced dental care or have the tooth removed.

The dental professions goal is to help and educate the patient, how to avoid them entering into this cycle of tissue amputation and periodic filling replacement. Oral care education and modern toothpastes have helped reduce the number of cavities, but in poorer communities, those with disabilities and in long term institutions, as well as our aging population, decay is still prevalent. And diet advice is often lacking, so although patients may think they are doing well at home, the process of decay continues! The days of 'Wait & Watch' are over the profession is not entirely sure of what it is watching unless clinicians are using advanced clinical diagnostic tools.

Dental Ozone is a completely new way to look at decay. In the early stages of mineral loss, no use of the drill is required. The treatment is simple, inexpensive (certainly less than the cost of a filling), and requires no injection of anaesthetics. This does of course depend on the use of modern diagnostic equipment, such as the DIAGNOdent (KaVo GmbH). This laser is more accurate than x-rays, and far superior to the traditional mirror and probe that dentists often use. The mirror and probe are tools that can find holes, not diagnose areas of first stage decay. And research has shown that x-rays are very poor to visualise decay in a tooth surface, until it is 2-3 mm inside the inner layer of the tooth.

If the area of decay is deeper, and more extensive, Ozone still has a role to play. The dental

drill may need to be used to remove the cover of enamel over the decay, but this can also be carried out with air abrasion. No local anaesthetics are required, and Ozone is used to sterilise the area of decay, without the need to amputate a large volume of tooth structure. In this way, damage to the tooth is limited, and the inherent strength is preserved. Even in really deep areas of decay, Ozone can be used to preserve tooth tissue.

When Ozone is combined with traditional care, then there are a number of advantages that patients and the dental profession can make use of. Ozone can be used to sterilise a cavity before a filling is placed, so there will be virtually no sensitivity after the local anaesthetic wears away. It can be used to eliminate sensitivity after new crowns or veneers are placed. And where wear facets have produced sensitive areas at the necks of teeth, in most cases a simple 40 second application with ozone can eliminate this sensitivity. There are many more applications for Ozone in a general dental or medical practice, and the studies for some of these can be found on www.the-o-zone.cc. This www site not only allows you to find a dental practice which has and uses Ozone, but also allows you to view the research papers that have been published from centres around the world.

There is not a single facet of a medical, dental or veterinary practice where ozone cannot be used in some form for the benefit of patients from the general to specialist practice and health care centre all can take advantage of this new technology.

So, perhaps a Monday morning at a dental practice that has invested in modern technology is no longer the stressful, painful and anxious visit that it used to be. The waiting room in this practice are full of smiles, people chatting to the dental team members as they wait with happy anticipation at being called through for their turn in the treatment room. Mums and dads with children have no fear or anxiety, as they are reassured that modern technology has opened a door for them, that most of the older population had never believed possible. For both the patient and the dental practice, it is a technology that has a winning solution for both; the treatment is fast, it is predictable, it is painless, and also reduces the long-term cost of the treated tooth. For the dental practice, the treatment times are reduced, it is profitable, and the treatment less stressful. For the patient, modern technology has allowed them to have a 21st century treatment, rather than one that is old fashioned, and out-dated.

In a lead article published in 2003 I wrote; 'In the vast majority of dental practices - not just in the United Kingdom and Europe, but throughout the world - the primary method to reverse the effects of decay remains 'drill and fill'. The entry of a patient into the cycle of drill and fill is irreversible. Once a hole is drilled into a tooth, the patient always will have it; and no matter how good a clinician each dentist perceives themselves to be, any restorative material will fail at some time.'
The dental profession has not kept up with their medical counterparts in finding a holistic treatment method for what is a prevalent infection caries. The Victorian principles of amputation to establish a sound foundation for restorative care no longer are valid in the light of new published research and clinical experience.
Ozone at last offers the dental profession this new approach instead of the out-dated and Victorian amputational model. --- Dr Julian Holmes, 2007.
The Ozi-cure is a self-contained device to generate ozone gas from air for the use in Dental, Medical or Veterinary Practice for surface application.

The Ozi-cure Dental Unit manufactured by O3 and distributed in Germany by American Dental GmbH. The Ozi-cure achieved CE and Medical Directive Certificates in November

2006.
The treatment times used in dental ozone treatment are short from 10 to 60 seconds (Baysan and Lynch, 2001). The area to be treated and the application of ozone is carefully controlled by localised 'bagging' and high-volume suction.
The use of ozone in dental practice takes dental care into the 21st Century. It sets the standard of a modern pharmaceutical method to treat dental and medical patients;

Studies from Europe (Abu-Salem et al, 2003; Baysan and Lynch 2001; Holmes, 2003; Holmes and Lynch, 2003) have shown conclusively that the use of ozone in dental care is effective as a non-destructive method to manage decay and its destructive effects. The use of ozone has been shown to be the ideal way to manage anxiety of patients young and old - and their carers (Dahnhardt et al, 2003; Domingo et al, 2004).
The effects of ozone reduce tooth destruction in routine preparation (Clifford, 2004; Holmes, 2004; Holmes and Lynch, 2004) and ozone reduces the time and the cost of dental care (Domingo and Holmes, 2004; Johnson et al, 2003) and raises the practice income. In Endodontics, ozone is effective against Enterococcus faecalis (Chang et al, 2003).
Professor Velio Bocci from Milan University (1994) has emphasised that the potential toxicity of O3 should not preclude its employment for medical, dental & veterinary purposes. This statement has been echoed by thousands of health professionals who use ozone in clinical practices around the world, and millions of patients that have been treated.
The correct operation of the Ozi-cure meets all current Health and Safety Regulations in all countries. The Ozi-cure is completely safe when used according to the Ozi-cure Operating Instructions.
Ozone is perceived to be a dangerous gas; let's put this into a scientific context. In 1978 an FDA Report showed that 1.5 million people were hospitalised by pharmaceutical reactions, and there were 140,000 deaths from prescription drug usage.
In stark contrast, a 1980 German Medical Society Report for Ozone Therapy cited 5.6 million ozone treatments carried out for that year. Of the 5.6 million ozone treatments, there were just 40 reported cases of side effects (0.000007%), and 4 deaths from inappropriate administration of ozone gas. Ozone remains the safest and effective pharmaceutical treatment.
In World War I, ozone was used to treat wounds, burns and infections. The modern development of ozone's application to Medicine began in the 1950s in Europe, Australia, Israel, Cuba, Brazil and Columbia. Today, over 9000 doctors, dentists & vets worldwide now routinely use ozone in their clinical management.
Research in Cuba, Europe, the USA and South Africa concerning the anti-microbial efficacy of ozone has continued over the last twenty years and has conclusively shown the ability of both gaseous and dissolved ozone to eradicate a wide range of bacteria, bacterial spores and viruses (Baysan and Lynch, 2001; Ishizaki, 1986; Katzeneleson, 1974; Vaughan, 1987; Whistler and Sheldon, 1989).
A clinical guide for the use of ozone in dental and medical practice is included with every Ozi-cure device sold.

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Chang H, Fulton C, Lynch E: Antimicrobial Efficacy of Ozone on Enterococcus faecalis.

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Clifford C: Reversal of Caries Using Airbrasion and Ozone- Nine Month Results. IADR Abstract 2004
Dahnhardt JE, Jaeggi T, Scheidegger N, Kellerhoff N, Francescut P, Lussi A: Treating Caries in Anxious Children with Ozone: Parents' Attitudes after the First Session. IADR Abstract 2003
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Katzeneleson E: Inactivation of viruses and bacteria by ozone. In chemistry of water supply, treatment and disinfection. Ann Arbor Science Publishers Inc., Ann Arbor, Mich, 1974.

Links

http://www.dentalozone.co.uk (Extensive bibliogaphy)
http://www.kavo.com (Dozens of downloadable PDF files)

OZONE DENTISTRY PATENTS

US 6409508
Use of ozone for the treatment of dental caries
Inventor: LYNCH EDWARD
EC: A61K33/40 IPC: A61K8/00; A61K8/18; A61K8/22 (+12)
2002-06-25

US 7172426
Use of ozone for the treatment of dental and oral conditions
Inventor: LYNCH EDWARD (GB); SCHEMMER JURGEN
EC: A61K6/00D; A61K8/22; (+3) IPC: A61K6/00; A61K8/22; A61K33/40 (+8)
2003-06-05
A method of treating gum disease provides for directing a stream comprising an oxidizing gas onto inflamed human gingiva for a period of time sufficient to kill microorganisms...

US 2003143164

Reductant rinse for use with ozone treatment of dental caries
Inventor: LYNCH EDWARD (GB); SCHEMMER JURGEN
EC: A61K8/22; A61Q11/00 IPC: A61C5/00; A61C5/00; (IPC1-7): A61K7/18
2003-07-31
A reductant rinse including xylitol prevents buildup in ozone carrying lines in apparatus for the treatment of dental caries.

US6773610
Method and system for controlling biofilm
Inventor: KORIN AMOS
EC: C02F1/78 IPC: C02F1/78; A61C1/00; C02F1/32 (+8)
2003-03-20
A method for removing biofilm from, and/or for preventing biofilm from forming on, an interior surface of a conduit that receives a supply of water, is performed by disabling the supply of water to the conduit, and passing an ozone-containing gas to the conduit. The ozone-containing gas can be generated from an oxygen-containing gas that is exposed to either a corona discharge or ultraviolet radiation. In an alternate embodiment, the water is disinfected by the ultraviolet radiation. The invention is especially suited for use with dental equipment.

US 2005112525
Dental apparatus with ozone irrigation system
Inventor: MCPHERSON ROGER (CA); JOHNSON PATRICK
EC: IPC: A61C5/02; A61C5/02; (IPC1-7): A61C5/02
2005-05-26

US 6267895
Catalytic dental water apparatus
Inventor: ENGELHARD ROLF (US); KASTEN STEPHEN P
EC: A61C1/00S4; A61L2/20C; (+3) IPC: A61C1/00; A61L2/20; C02F1/72 (+11)
2001-07-31

US 2002127158
Portable water ozonator and air/water supply control unit
Inventor: HOLSCLAW RALPH L (US); ELLIS RAY S
EC: A61L2/18; A61L2/20C IPC: A61L2/18; A61L2/20; C02F1/78 (+5)
2002-09-12

US 5824243
Water ozonating system
Inventor: CONTRERAS EDWARD M
EC: B01F5/10F; C02F1/78 IPC: B01F5/10; C02F1/78; B01F3/04 (+6)
1998-10-20

US 2002134736
Operatory water disinfection system
Inventor: BURRIS WILLIAM A (US); PRINSEN PHILLIP
EC: A61C1/00S4; A61L2/18; (+3) IPC: A61C1/00; A61L2/18; A61L2/20 (+8)
2002-09-26

DE 19932570

Dental antimicrobial preparation comprises olive and/or castor oil enriched with ozone, releases oxygen to control anerobic bacteria...
Inventor: STEIDL GERHARD (DE); KACZMAREK ANDRE
EC: A61K6/00; A61K8/22; (+2) IPC: A61K6/00; A61K8/22; A61K8/92 (+8)
2001-01-18

DE 3324939
Method and device for the cleaning and disinfection of medical, especially dental, instruments
Inventor: HOHMANN EUGEN ING GRAD
EC: A61L2/20C IPC: A61L2/20; A61L2/20; (IPC1-7): A61L2/20 (+1)
1985-01-24

WO 2006014080
METHOD AND APPARATUS FOR SUPPLYING WATER IN DENTAL WATER TANK
Inventor: KOO CHA HYOUNG
EC: A61C1/00S4; A61C1/00S6; (+1) IPC: (IPC1-7): A61C17/032
2006-02-09

WO 2005032393
DENTAL APPARATUS WITH OZONE IRRIGATION SYSTEM
Inventor: MCPHERSON ROGER W (CA); JOHNSON PATRICK
EC: IPC: A61C5/02; A61C; A61C5/02 (+1)
2005-04-14

WO 02078663
REDUCTANT RINSE FOR USE WITH OZONE TREATMENT OF DENTAL CARIES
Inventor: LYNCH EDWARD (GB); SCHEMMER JURGEN
EC: A61K8/22; A61Q11/00 IPC: A61K8/00; A61K8/20; A61K8/21 (+12)
2002-10-10

WO 02078644
USE OF OZONE FOR THE TREATMENT OF DENTAL AND ORAL CONDITIONS
Inventor: LYNCH EDWARD (GB); SCHEMMER JURGEN
EC: A61K6/00D; A61K8/22; (+3) IPC: A61K6/00; A61K8/22; A61K33/40 (+12)
2002-10-10

WO 9965533
CATALYTIC DENTAL WATER APPARATUS
Inventor: ENGELHARD ROLF (US); KASTEN STEPHEN P
EC: A61L2/20C; C02F1/72K; (+2) IPC: A61L2/20; C02F1/72; C02F1/74 (+8)
1999-12-23

WO 9953966
AN APPARATUS AND A METHOD FOR STERILISING A MEMBER
Inventor: BUSTED TOMMY (DK)
EC: A61L2/10; A61L2/20C IPC: A61B1/12; A61L2/10; A61L2/20 (+7)
1999-10-28

WO 9742924
DENTAL UNIT WATER PURIFIER
Inventor: ENGELHARD ROLF (US); KASTEN STEPHEN P (US)
EC: A61C1/00S4; C02F1/78 IPC: A61C1/00; C02F1/78; A61C1/00 (+3)
1997-11-20

WO 9306948
A CLEANSING AND STERILIZATION MECHANISM
Inventor: LANGFORD TERRENCE
EC: A61L2/20C; A61L11/00; (+2) IPC: A61L2/20; A61L11/00; A61L12/12 (+11)
1993-04-15

WO 02066079
OPERATORY WATER DISINFECTION SYSTEM
Inventor: BURRIS WILLIAM A; PRINSEN PHILLIP M
EC: A61C1/00S4; A61L2/18; (+3) IPC: A61C1/00; A61L2/18; A61L2/20 (+8)
2002-08-29

EP 0988834
Devices for use in disinfection treatments and method for cleansing dental implantological elements
Inventor: SCHAFRAT B (NL)
EC: A61C5/14; A61C19/06; (+1) IPC: A61C5/14; A61C19/06; A61L2/20 (+4)
2000-03-29

EP 1372572
USE OF OZONE FOR THE TREATMENT OF DENTAL AND ORAL CONDITIONS
Inventor: LYNCH EDWARD (GB); SCHEMMER JURGEN
EC: IPC: A61K6/00; A61K33/00; A61L9/00 (+6)
2004-01-02

JP 9201374
DENTAL TREATMENT UNIT
Inventor: CHATANI MASARU
EC: IPC: A61C17/00; A61L2/20; A61C17/00 (+3)
1997-08-05

JP 3186257
DENTAL UNIT
Inventor: RENAATE BUIIBAAN; ERUNSUTO GERUHARUTO BETSUKU
EC: A61C1/00S4 IPC: A61C17/00; A61C1/00; A61C19/00 (+17)
1991-08-14

JP 2252460
APPARATUS FOR DISINFECTING AND STERILIZING DENTAL HANDPIECE
Inventor: MASUDA SENICHI
EC: IPC: A61C1/08; A61L2/18; A61L2/20 (+6)
1990-10-11

JP 1181869
STERILIZER FOR DENTAL SURGERY

Inventor: MASUDA SENICHI
EC: IPC: A61C19/00; A61L2/20; A61C19/00 (+3)
1989-07-19

JP 63292961
APPARATUS FOR STERILIZING DENTAL IMPRESSION
Inventor: MASUDA SENICHI; HOASHI NOZOMI
EC: IPC: A61L2/20; A61C9/00; A61L2/20 (+3)
1988-11-30

JP 63281656
APPARATUS FOR DISINFECTING AND STERILIZING DENTAL INSTRUMENT
Inventor: MASUDA SENICHI
EC: IPC: A61L2/20; A61L2/20; (IPC1-7): A61L2/20
1988-11-18

JP 63281655
APPARATUS FOR DISINFECTING AND STERILIZING DENTAL INSTRUMENT
Inventor: MASUDA SENICHI
EC: IPC: A61L2/20; A61C19/00; A61L2/20 (+2)
1988-11-18

JP 62047355
APPARATUS FOR SUPPLYING OZONE AIR AND OZONE WATER TO DENTAL TREATMENT STAND
Inventor: KANEUCHI KIYOSHI
EC: IPC: A61C19/00; A61C19/00; (IPC1-7): A61C19/00
1987-03-02

JP 11137580
WASHER FOR DRAIN HOSE IN DENTAL TREATMENT UNIT
Inventor: TSUJI YASUSHI
EC: IPC: A61C19/00; A61C19/00; (IPC1-7): A61C19/00
1999-05-25

JP 9000548
DENTAL DIAGNOSTIC DEVICE
Inventor: ASANAMI SOICHIRO; MATSUO MAKOTO
EC: IPC: A61C17/00; A61C19/00; A61C17/00 (+3)
1997-01-07

JP 2002253582
WASTEWATER TREATMENT EQUIPMENT FOR DENTAL CHAIR UNIT
Inventor: KIMURA SHIYUUSUKE; NOGUCHI KUNITOSHI
EC: IPC: A61C17/00; A61G15/10; A61L2/18 (+17)
2002-09-10

JP 2002248116
DRAINAGE PROCESSING DEVICE FOR DENTAL CHAIR UNIT
Inventor: KIMURA SHIYUUSUKE; NOGUCHI KUNITOSHI
EC: IPC: A61C17/00; A61L2/18; A61L2/20 (+15)

2002-09-03

CN 1594137
Ozone water sterilizing device for integrated controlled dental therapy bench
Inventor: YIN KAI (CN); ZHOU HONGFEN
EC: IPC: C02F1/78; C02F1/78; (IPC1-7): C02F1/78
2005-03-16

CN 2707208Y
Ozone dental therapeutic device
Inventor: ZHU GE
EC: IPC: A61C17/02; A61H33/14; A61C17/00 (+3)
2005-07-06

CN 1778395
Method for disinfecting polluted zones of high speed dental turbo hand-machine
Inventor: LIU FAN HONG
EC: IPC: A61L2/18; A61L2/18
2006-05-31

KR 20040080111
WATER SUPPLY SYSTEM FOR DENTAL SERVICES
Inventor: LEE GYU HYEON
EC: IPC: C02F1/78; C02F1/78; (IPC1-7): C02F1/78
2004-09-18

KR 20010035546
AUTOMATIC WATER SUPPLY SYSTEM FOR DENTAL WATER TANK AND OZONE GENERATOR SET IN THE TANK
Inventor: HAN IN HEE
EC: IPC: A61C17/024; A61C17/00; (IPC1-7): A61C17/024
2001-05-07

US Patent # 6,409,508

Use of Ozone for the Treatment of Dental Caries

Edward Lynch
(June 25, 2002)

Abstract --- This invention concerns the use of ozone in the treatment of dental caries.

Current U.S. Class: 433/226
Current International Class: A61K 33/40 (20060101)
Field of Search: 433/226,216,88
References Cited [Referenced By]
U.S. Patent Documents: 4060600 (November 1977) // 4438100 (March 1984) // 4743199 (May 1988) // 5942125 (August 1999)
Foreign Patent Documents: FR 2187288 (Jan., 1974)

Description

This invention relates to the use of ozone in the treatment of dental caries.

The great destructive disease of teeth is dental caries which may be defined as the acid dissolution of enamel, dentine or cementum as a consequence of the metabolism of micro-organisms living within deposits on the teeth known as plaque. Dental caries are believed to be associated with specific micro-organisms, the principal ones being Streptococcus Mutans, Lactobacilli, Actinomyces Visosus Serovar 2, Actinomyces Naeslundii and "Intermediate" Actinomyces, other Streptococci and yeasts. These are acid producing micro-organisms which produce acids such as acetic and lactic acids from the dietary carbohydrates. The micro-organisms associated with dental caries are unique and are ecologically very different from those associated with, for example, infected root canals.

Dental caries is currently managed by one or more of the following:

(i) preventive treatment by, for example, dietary and oral hygiene measures and may include the topical application of chemotherapeutic agents;

(ii) the removal of dentine exhibiting the signs of active caries;

(iii) the protection of any newly exposed non-carious dentine with restorative material.

Measures aimed at the prevention or the arrest of dental caries are mainly based on the elimination of dental plaque from the surfaces of roots and the institution of dietary controls to reduce the frequency and quantity of readily fermentable carbohydrate ingestion. The mechanical removal of plaque has been a major platform for the prevention of dental caries for some time. However, this poses special problems in the case of primary root caries due to access problems. Because dentine has a Knoop hardness of 68 in contrast to enamel at 11, the mechanical removal of plaque from its surface inevitably results in some loss of tissue also. Toothbrush abrasion is now a very common phenomenon and invariably leads to the loss of root dentine from the facial aspects of teeth. Consequently, the traditional methods of plaque control in the prevention of dental caries create further problems even when access permits it to be used effectively.

Conventional caries removal and cavity preparation entail the use of high and low speed handpieces. However, disadvantages of this system include the perception that drilling is unpleasant for patients and local anaesthetic is frequently required. Furthermore, handpieces are expensive to purchase and maintain and their use may lead to the removal of softened but uninfected dentine resulting in the excessive loss of tooth tissue.

Where restoration is required, all materials used to restore carious lesions have their limitations. For example, gold and ceramic are expensive and present a technical challenge for the practitioner. While amalgam is a durable, predictable material, it has poor aesthetic qualities, is potentially toxic and may cause allergic reactions in some people.

It is an object of the invention to alleviate the disadvantages of the prior art.

It has now unexpectedly been found that ozone can penetrate carious tissue and can therefore be used in the treatment of dental caries.

According to the present invention there is provided the use of ozone in the preparation of a therapeutic system for the treatment of dental caries.

As used herein, the term "ozone" is intended to embrace pure ozone, oxonised air and ozonised aqueous media, such as water optionally containing a reductant, such as thiocyanate or peppermint.

The ozone is delivered at a pressure sufficient to penetrate the carious tissue and at a concentration and for a period of time sufficient to kill substantially all of the micro-organisms within the carious lesion.

Preferably, a needle-sized jet of pure ozone or ozonised air in a shroud of micro-organism-free aqueous medium, e.g. water optionally containing a reductant, is injected at the desired location.

If desired, a sealant of the type known in the art may be applied to a carious lesion following ozone treatment.

The advantages of using ozone in the treatment of dental caries include the following:

1. It eliminates drilling and its attendant problems;

2. It is rapid and painless;

3. It does not require sophisticated methods of isolating the tooth;

4. No local anaesthetic is required.

The invention is illustrated in the following Examples. Unless otherwise stated, the ozone delivered in the following Examples is present in air at a concentration of 5.2%.

EXAMPLE 1

Many studies concerning the clinical evaluation of ozone have been based on assessments of its harmful effects rather than demonstrating any therapeutic benefits it may offer. Ozone is one of nature's most powerful oxidants which accounts for its ability to kill bacteria, spores and viruses. Uniquely, ozone decomposes to a harmless, non-toxic and environmentally safe material (oxygen). In this investigation, a multicomponent evaluation of the oxidative consumption of salivary biomolecules by ozone (O.sub.3) has been performed using high resolution proton (.sup.1 H) nuclear magnetic resonance (NMR) spectroscopy. The ozone-generating equipment employed in this study was designed by Purezone Ltd. (Ipswich, U.K.). Unstimulated human saliva samples were collected from 8 patients and each of them was divided into two equivalent portions (0.60 ml). The first of these was treated with O.sub.3 generated from the above device for a period of 30 seconds; the second group of portions served as controls. Samples were subjected to .sup.1 H NMR analysis at an operating frequency of 600 MHz. Results acquired revealed that O.sub.3 treatment gave rise to (1) the oxidative decarboxylation of the salivary electron-donor pyruvate (generating acetate and CO.sub.2 as products), (2) oxidation of the volatile sulphur compound precursor methionine to its corresponding sulphoxide and (3) the oxidative consumption of salivary polyunsaturated fatty acids. Moreover, evidence for the O.sub.3 -mediated oxidation of salivary 3-D-hydroxybutyrate was also obtained. High field .sup.1 H NMR spectroscopy

provides much useful analytical data regarding the fate of O.sub.3 in human saliva, information which is of much relevance to its potential therapeutic actions in vivo.

EXAMPLE 2

Ozone Effect on Microflora from Primary Root Caries Ex-vivo

Primary root carious lesions (PRCL) are a major clinical problem. The aim of this study was to establish if ozone could achieve effective microbial killing in PRCL. An ozone producing generator (Purezone Ltd., Ipswich, U.K.) was used in this ex-vivo study assessing the use of ozone on PRCL. In this study, soft PRCL requiring restoration were used as these are the most severe type of lesion found in humans. 20 freshly extracted teeth with PRCL requiring restoration were used. After plaque removal using a hand held standard fine nylon fibre sterile toothbrush with sterile water as a lubricant to cleanse the surface, each tooth was then isolated using sterile cotton wool rolls and dried using a dry sterile cotton wool roll. A sample of PRCL was taken using a sterile excavator from half of the most active part of the lesion. Subsequently, 10 seconds of the ozonised water was applied to the lesion and another sample was taken from the other half of the most active part of the lesion. Each sample was weighed and immediately placed in 1 ml of Fastidious Anaerobe Broth (FAB). To each 1 ml of FAB containing a biopsy of carious or ozone treated carious dentine, sterile glass beads were added. They were vortexed for 30 seconds to facilitate the extraction of any micro-organisms from the carious dentine and disperse any aggregates. After decimal dilution with FAB, 100 ml aliquots of these was spread on Fastidious Anaerobe Agar (LabM. Bury, Lancs., U.K.) supplemented with 5% (V/V) horse blood in an anaerobic chamber at 37.degree. C. for four days. The mean.+-.SE number of each colony type was counted and calculated.

Before Ozone After 10 Seconds of Treatment Ozone Treatment Mean .+-. SE of 5.91 .+-. 0.15 3.57 .+-. 0.37 total cfu (Log.sub.10)

Using the paired Student t-test a significant difference ($p<0.001$) was observed between the two groups. Clearly, the percentage of micro-organisms killed associated with the use of ozone was more than 99%.

EXAMPLE 3

Ozone Effect on Microflora from Primary Root Caries Ex-vivo

The procedure of Example 2 was repeated except that ozonised water was applied to the lesion for 20 seconds. Using the paired student t-test, a significant difference was observed in the ozonised water group (log.sub.10 3.77.+-.0.42, mean.+-.SE) compared with the control group (log.sub.10 6.18.+-.0.21) ($p<0.001$).

The results of these tests show that the use of ozone can provide an effective, rapid and simple means for killing micro-organisms in carious lesions.

EXAMPLE 4

Sealant Shear Bond Strength to Sound and Carious Radicular Dentine

There has been little research on the interaction between primary root carious lesions (PRCL) and adhesive materials. The aim of this study was to examine the shear bond strength of four

adhesive systems to PRCL with sound dentine acting as a control. The adhesive systems used were:

1. OptiBond FL Prime.sup.1 /OptiBond FL Adhesive.sup.1 /OptiGuard.sup.1

2. OptiBond FL Prime/OptiGuard

3. OptiGuard and

4. ChemFil II.sup.2

The materials were applied to sound radicular dentine and PRCL in vitro in freshly extracted teeth. The bonding site was macroscopically intact, was flat and had at least a 3.5 mm diameter. 37% phosphoric acid was used for 15 seconds in samples in groups 1.fwdarw.3 whilst 25% polyacrylic acid was used in group 4. After bonding the samples were stored for seven days in a moist atmosphere at 37.degree. C. A shearing force was applied at 1 mm/minute. There were at least 10 samples in each group. The mean (s.e.) shear bond strengths were (MPa);

Adhesive Control Carious OptiBond FL Prime/OptiBond 5.31 (1.03) 5.58 (1.05) FL Adhesive/OptiGuard OptiBond FL Prime/OptiGuard 2.01 (0.59) 1.63 (0.40) OptiGuard 0.73 (0.24) 1.45 (0.52) ChemFil II 1.42 (0.28) 1.01 (0.26)

While statistical testing showed that the shear bond strength of the OptiBond FL Prime/OptiBond FL Adhesive/OptiGuard was significantly the highest, ($p<0.001$), the caries status of the root surface had no significant influence on the bond strength. OptiGuard in combination with OptiBond FL Prime and OptiBond Adhesive had the highest bond strength and this was not influenced by the caries status of the surface.

.sup.1 Kerr, Romulus, Mich. U.S.A.;

.sup.2 Dentsply, Konstanz, Germany.

EXAMPLE 5

The Effect of Ozone on Primary Root Caries and Associated Micro-organisms

The aims of these studies were to evaluate the efficiency of ozone on primary root caries and associated micro-organisms (Streptococcus sobrinus; TH 21, Streptococcus mutans; NCTC 10449). In study 1, 40 soft primary root carious lesions (PRCLs) from freshly extracted teeth were used and randomly divided into two groups to test the exposure to ozone for either 10 or 20 seconds. There was a significant ($p<0.001$) difference (Mean.+-.SE) between the control samples for. either 10 seconds (log.sub.10 5.91.+-.0.15) or 20 seconds (log.sub.10 6.18.+-.0.21) and ozone treated samples for either 10 seconds (log.sub.10 3.57.+-.0.37) or 20 seconds (log.sub.10 3.77.+-.0.42). In study 2, 40 sterile saliva coated glass beads were put into bijoux bottles with 3 mls of Todd Hewitt broth for control and test groups. S. sobrinus and S. mutans were inoculated and incubated anaerobically overnight. Each glass bead was washed with 2 mls of PBS. Immediately, 10 seconds of ozone was applied to the glass beads in the test groups. Subsequently, each glass bead in the test and control groups was placed in 3 mls of Todd Hewitt Broth with six more sterile glass beads and were vortexed for 30 seconds. After decimal dilutions, 100 ml aliquots were spread on blood agar plates

supplemented with 5% (V/V) horse blood and placed in an anaerobic chamber at 37.degree. C. for two days. The number of each colony type was counted and calculated. Using the paired student t-test, there was a significant reduction ($p<0.0001$) (Mean.+-.SE) between the control samples for S. sobrinus (log.sub.10 4.61.+-.0.13) and S. mutans (log.sub.10 3.93.+-.0.07) and ozone treated samples for S. sobrinus (log.sub.10 1.09.+-.0.36) and S. mutans (log1.01.+-.0.27). This treatment regime is therefore an effective, quick, conservative and simple method to kill micro-organisms in primary root carious lesions.