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Newer non-surgical modalities in the periodontal therapy

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Abstract

Continuous experiments and research in the field of dentistry have led to emerging ideas of less invasive procedures for an effective periodontal rehabilitation. This article summarizes the concept of latest Non-surgical treatment in periodontics which include usage of lasers, probiotics, ozone and photodynamic therapy, gene therapy and the evolving science of periodontal vaccines.

Keywords: Periodontal vaccine, laser, ozone therapy, probiotics, gene therapy, photodynamic therapy

Introduction

The evolving Science and practice in the field of Periodontology has drastically changed the concepts of periodontal health and disease unfurling newer prospects of treatment. Mechanical or the Non-Surgical treatment method provided as Scaling, root planing and subgingival debridement along with contraptions for Oral Hygiene maintenance have been the Gold standard for Basic Periodontal Therapy.

With the continuing advancements in the provision of oral health care, newer non-surgical and adjunctive approaches in diagnosis, adjunctive procedures and self-maintenance techniques have come forth as a promising panache and may help to arrest periodontal disease without surgical intervention. An evolving history of various such newer methods in the recent years have been summarized below.

Lasers:

After the development of the first laser in 1960, the dental researchers began investigating their potential and in 1965, Stern and Sognaes reported that a ruby laser could vaporize enamel. In 1990, the first pulsed Nd: YAG laser designed especially for dental use was developed. FDA clearance of the first Er: YAG and Er,Cr: YSGG laser was obtained in 1997 [1].

Er: YAG laser seems to provide the most suitable characteristics for various types of periodontal treatment. In particular, it shows the most promise for root surface treatment and is safe and efficient for use in periodontal bone surgery when used with concomitant water irrigation.

Erbium-Chromium doped: Yttrium-Selenium Gallium- Garnet (Er. Cr: YSGG) laser is commercially available as Waterlase. It uses a patented combination of laser energy and water by a process called Hydro photonics, to perform a wide range of dental procedures [2].



Waterlase- Laser equipment

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Photodynamic Therapy

It is based on the principle that the photosensitizer (photo-activatable substance) binds to the targeted cells and then can be activated by light of the appropriate wavelength in the presence of oxygen. This results in the generation of singlet oxygen and free radicals, which are extremely toxic to certain cells and bacteria.

The use of photodynamic therapy was first reported by a Danish physician, Niels Finsen. In 1978, studies by Thomas Dougherty and co-workers showed striking results from clinical testing of this therapy employed on malignant tumours [3].

Inactivation of microorganisms using photodynamic therapy has been defined as either antimicrobial photodynamic therapy (aPDT), photodynamic antimicrobial chemotherapy (PACT) or photodynamic disinfection.

Periodontal bacteria demonstrate susceptibility to photodynamic therapy in the planktonic phase; however, aPDT alone has not proven to be much potent. Scaling and root planning with an adjunctive aPDT has however shown to improve clinical and microbiological parameters. Methylene blue mediated aPDT (Periowave) is an example of PDT employed in periodontics [4].



Picture showing aPDT equipment and it's use on a patient

Probiotics

The World Health Organization has defined Probiotics as live organisms, which, when administered in adequate amounts, confer a health benefit on the host. First Probiotic species to be introduced in research was *Lactobacillus acidophilus* by Hull *et al.* in 1984.

The ability of probiotics to lower the pH in the oral cavity along with it's antioxidant properties of neutralizing free electrons required for mineral formation have shown to reduce plaque and calculus formation. Their potency to breakdown putrescence odours make them useful in eliminating halitosis. *S. salivarius* is known to produce bacteriocins which could contribute in reducing the number of bacteria that produce volatile sulphur compounds. A majority of the strains including *L.salivarius* have been studied and were shown to suppress the growth of *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* and *Prevotella intermedia* [5].

Clinical studies with *Lactobacillus reuteri* strains by administering chewing gums and other forms twice a day for 2 weeks along with Scaling and root planning showed improved clinical parameters in the subjects [6]. *Lactobacillus acidophilus*, *L. casei*, *L. lactis*, *L. salivarius*, *L. plantrum*, *L. bulgaricus*, *L. rhamnosus*, *L. reuteri*, *Streptococcus thermophilus*, *E. faecalis*, *Bifidobacterium bifidum* are commonly used bacterial probiotics. Probiotics can be in powder form, liquid form, gel, paste or granules.

Examples of Commercially available probiotics for periodontal concerns include Gum PerioBalance, Peribiotic,

Acilact, Vitanar and prodentis.



Probiotic in lozenge form

Ozone therapy

Ozone as a disinfectant in medicine was first used and introduced by Landler in 1870 and in year 1932, Dr. E.A.Fisch- a swiss dentist had the first idea to use ozonated water or gas in his practice [7].

Ozone is a powerful oxidizer - it effectively kills bacteria, fungi, viruses, and parasites at a dramatically lower concentration and no toxic side effects. Along with anti-hypoxic effect of reducing inflammatory processes, ozone causes synthesis of biologically active substances such as interleukins, leukotrienes, and prostaglandins which are beneficial in reducing inflammation and promote wound healing. Ozone can be used in the form of Ozonated Water, Gaseous Ozone or Ozonized oils.

Ozonated water in various experimental studies has been found effective for killing gram-positive and gram-negative oral microorganisms and oral *Candida albicans* in pure culture as well as bacteria in plaque biofilm and therefore might be useful as a mouth rinse to control infectious microorganisms in dental plaque. Similar reduction in bacterial counts and improved probing depths have been seen in periodontal pockets irrigated with ozonized water and therefore merit further investigation in periodontal therapy [8].

HealOzone®, OzonyTron®, Prozone® are some commercially available appliances used for ozone production in dental treatment.



HealOzone delivering equipment

Gene Therapy

Application of growth factors or soluble forms of cytokine receptors by gene transfer provides a greater sustainability than that of single protein application. Gene therapy may achieve greater bioavailability of growth factors within periodontal wounds, which may provide greater regenerative potential. It includes In-Vivo gene transfer and Ex-vivo gene delivery. Gene therapy studies utilizing bone morphogenetic

proteins (BMPs) have been performed and bone fibroblasts were used to stimulate repair of alveolar bone wounds [2].

Periodontal Vaccine

Periodontal disease initiated by oral pathogens includes the nature of host microbial interactions and this is where the modus operandi of the Vaccines exist. In the early 20th century, periodontal vaccines were employed which included pure cultures of streptococcus and other organisms, autogenous vaccines and stock vaccines. Vancott's Vaccine and Inava endocarp Vaccine are examples of perio vaccines that were developed [9]. Nasal Sprays, Gene Guns, Transcutaneous patch delivery system are various modes of Immunization that can be used for periodontal vaccination.

Active immunization by Bacterial whole cells, Gingipains, Fimbriae, Heat shock proteins studied through various experiments have shown to induce a protective immune response by production of IgG antibodies and blockage of PGE2 response to Lipopolysaccharide of the pathogenic bacterial cell. Passive immunization by Murine monoclonal antibodies and plantibodies and Genetic immunization by live viral vectors have also been studied as potential periodontal vaccines [9].

All the studies pertaining to periodontal vaccine have been restricted to non-human primates till date but the successful results show a promising future of Vaccines in periodontal disease control in the near future. Development of a multispecies vaccine targeting all and main pathogens of periodontal disease would be an innovative and useful strategy to tackle periodontal disease related morbidity in humans.

Nanotechnology

Introduction of Nano-medicine was first put forward by Robert A. Freitas Jr. in 1993. It is the science and technology of diagnosing treating and preventing disease and traumatic injury of relieving pain, and of preserving and improving human health, through the use of nanoscale structured materials, biotechnology and genetic engineering and eventually complex molecular machine system and Nanorobots.

Nanorobotics is the technology of creating machines at or close to the microscopic scale of nanometers. Nanorobots are able to distinguish different cell types by checking their surface antigens. When the task of nanorobot is completed they can be retrieved by allowing them to exfuse themselves via the human excretory channels.

Triclosan nanoparticles have been used experimentally and shown to reduce inflammation of experimental sites. Timed release of drugs may occur from biodegradable nanospheres. A good example is Arestin in which tetracycline is incorporated into microspheres for drug delivery by local means to a periodontal pocket.

Nanorobots incorporated in mouthwash could identify and destroy pathogenic bacteria leaving behind harmless oral flora to flourish. Being suspended in liquid and able to swim about, they reach surfaces beyond bristles of tooth brush or the fibers of floss. Nanotechnology has the potential to produce non-biologic self-assembling systems for tissue engineering purposes. It is possible to create polymer scaffolds in the future for cell seeding, growth factor delivery and tissue engineering via nano-devices implanted to sites of tissue damage [10].

Reconstructive dental nanorobots, using native biological materials, could selectively occlude specific tubules within

minutes, offering patients a quick and permanent cure for dentinal hypersensitivity. Silver nanotechnology chemistry has proven to be effective against biofilms by disrupting critical functioning of the microorganisms.

Functions may be controlled by an onboard nano-computer executing programmed instructions in response to local sensor stimuli. Alternatively, the dentist may issue strategic instructions by transmitting his orders directly to in vivo nanorobots via acoustic signals (e.g. ultrasound) or by other means. The treatment Opportunities provided by nanorobotics would be in terms of tooth repair, hypersensitivity cure and Nanorobotic dentifrice (Dentifrobots) [11].

Resolvin- Anti Inflammatory Agents

Resolvins (resolution - phase interaction products) are endogenous mediators having an anti-inflammatory role. They reduce neutrophil trafficking, regulate production of cytokines and reactive oxygen species and have been successfully evaluated in ligature induced P gingivalis provoked animal model periodontitis. Prior application of Resolvin E1 has been shown to prevent animal models from developing periodontitis in contrast to unprotected animals which showed progressive disease [2].

Perioprotect

PerioProtect is a comprehensive method customized for individual patients to help manage biofilms growing in the spaces or pockets between teeth and gum tissue. The method is a combination of treatments, including a non-invasive chemical debriding therapy used in conjunction with traditional mechanical debriding procedures. The chemical therapy involves a tray delivery of doctor-prescribed solutions to chemically debride biofilm from the periodontal pocket and alter the pocket's microbiological environment to disrupt biofilm growth. Hydrogen peroxide gel, locally administered using PerioProtect (prescription customized trays) in the treatment of subjects with moderate to advanced periodontitis has shown statistically significant clinical improvements in pocket depths and bleeding when compared with Scaling and root planing alone.



Perioprotect kit with Trays and gel

RNA interference (RNAi)

RNAi works through small RNAs of approximately 20 to 30 nucleotides that guide the degradation of complementary or semi complementary molecules of messenger RNAs (posttranscriptional gene silencing) or interfere with the expression of certain genes at the promoter level (transcriptional gene silencing). RNAi In periodontal

regeneration through the silencing of genes that negatively control cell proliferation and cell differentiation or genes that induce inflammation or apoptosis, RNAi may favor tissue regeneration. Tumor necrosis factor- α -targeted siRNA can suppress osteolysis induced by metal particles in a murine calvaria model, opening the way to the application of RNAi in orthopedic and dental implant therapy^[5].

Current paradigm in Dentistry represents a time in history when there is a convergence between clinical dentistry and medicine, human genetics, molecular biology, biotechnology, bioengineering, and bioinformatics, resulting in the emergence of novel regenerative therapeutic approaches and focusing mainly on non-surgical modalities that would herald a new era in periodontal treatment in patients.

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