Research Paper

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Laser Assisted Photodynamic Therapy – The Future of Endodontics

Medical Science

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ABSTRACT

It has long been known that the primary determinant of the outcome of any endodontic intervention is the efficiency of the Disinfection protocol followed and thereafter the integrity of the post endodontic restoration. Therefore, ever since the inception of endodontics as a science and more recently as an art, clinicians have been in search of the 'Holy-Grail' for achieving a sterile root canal. One of the novel approaches to achieve the said goal, has been the use of Lasers to activate certain photo-dynamic agents placed within the canal of the tooth on which endodontic therapy is being performed. The disinfection technique described in the present article is called Photodynamic Therapy (PDT) previously known as Photo-Activated Disinfection.

INTRODUCTION

The principal aim of endodontic treatment has always been to eliminate as many microbes as possible within the realms of the root canal system there by achieving a nearly sterile canal space which could be efficiently sealed and obturated. In the process it is also important that we stick to being as less invasive as we possibly could.1 The age –old school of thought that we could sacrifice as much dentin as we needed to achieve absolute debridement (Concept of Clean dentinal shavings) is being questioned today since we have a plethora of technical advancements at our disposal which promise less-invasive yet very promising results. The use of a diode Laser as part of an assisted photodynamic therapy regimen is one such fresh option to achieve endodontic nirvana!

A combination of Toluidine blue O solution (TBO) and light at 633 ± 2 nm kills bacteria in a process which had long been termed 'Photo-activated disinfection' or PAD. A new light delivery system using this process achieved bacterial kills of the order of 109 cfu/ml (100% kill) of Streptococcus mutans 2. But considering the nuances of the complete regimen, Laser assisted Photodynamic therapy is a more appropriate terminology to be used.

HISTORY

During early 1990's at the Eastman Dental Institute, London (E.D.I) Prof. M. Wilson and Prof. G. Pearson first proved that photo activated disinfection killed Streptococcus mutans in significant numbers and reasoned that PAD could kill all bacteria involved in oral infections in caries, root canals as well as periodontal tissues.

They suggested the use of a special liquid together with laser light that which could eliminate the bacteria on a tooth surface, in a cavity or in a root canal. The process being energy and dose dependent (Power X Time). It proved to be a breakthrough in the fight against pathogenic bacteria since It was not only fast and effective but also minimally invasive disinfection system making it ideal for endodontic therapy.

Components

There are 2 principal components:

1) Disinfecting Dye / Photodynamic solution:- A dilute solution containing pharmaceutical grade tolonium chloride which was established as the most effective photodynamic agent packed either in dropper bottles (for caries treatment) or syringes (for delivery to root canals). (FIG 1 & 2)

2) Therapeutic Laser: A low power soft laser / LLLT device of 635 nm light source which optimally activates the solution. (FIG 3)

MECHANISM OF ACTION OF PDT 3

The disinfecting system basically consists of two components ie., dilute solution of tolonium chloride (a vital stain) and light source of a specific wavelength (635 nm). After application of PDT solution it penetrates into dental hard tissue through a process of diffusion and selectively tags bacteria. When activated by the light, singlet oxygen radicals are released. These attach to the site on the cell wall of bacteria at the same points where tolonium chloride was previously attached. This results in bursting of bacterial cell wall leading to bacterial lysis.4, 2 (FIG 4A, 4B, 4C & 4D)

FACTORS AFFECTING THE OUTCOME OF PDT

- Type of dye
- Dye concentration
- Irradiation parameters
- Power, time and power density
- Species of micro-organism

SIGNIFICANCE OF 635nm LASER OUTPUT / LLLT DEVICE

1) Low power 635 nm is used as light source because at 635nm, the transmission of light through demineralised dentine is 10 times more than mineralised dentin. This means that light at 635nm is transmitted efficiently through infected dentin surrounding the root canals but effectively stops at the interface with sound tissue.

2) At 635nm, it kills maximum number of bacteria upto 99.9%.5

EFFECT OF PDT ON ROOT CANAL MICROFLORA

PAD has been shown to kill all types of bacteria commonly found in caries and root canals including:6

1 Streptococcus mutans
2 Streptococcus sobrinus
3 Streptococcus intermedius
4 Actinomyces
5 Lactobacillus
6 Veilonella
7 Prevotella intermedia
8 Fusobacterium nucleatum
9 E. faecalis

OTHER CLINICAL APPLICATIONS OF PAD

1 Dental caries
2 Pit and fissure caries
3 Disinfection of root canals
4 Periodontal pockets
5 Disinfection of impression material
6 Site of peri-implantitis7

PDT AT THE PULP-CARIES INTERFACE : Though minimally invasive approach is preferred in the treatment of deep carious lesions (necessitating the use of IPT/DPT/Pulpotomy in children) current methods of removing infected tissue are not fool proof8,9. Kidd et al. [1996] have proposed that if the softened and wet dentine is eliminated followed by effective sealing of the cavity with a restorative being 'healing of the lesion' could be achieved as the bacteria become quiescent.10 Because once the bacteria are killed, bulk of the lactic acid producing complex is eliminated thus shifting the activity from favoring the caries lesion to complete resolution of pulpal lesion.

ENDODONTIC APPLICATION

Studies have shown that Micro-organisms could persist in the apical region of the root canal system despite chemomechanical preparation.11

Hence PDT can be undertaken as part of the routine disinfection of the root canal system, since it also has the potential to eradicate chronically persistent endodontic infections for which conventional methods have been unsuccessful.12

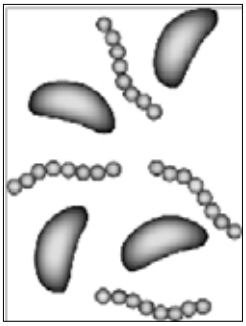
CONCLUSION

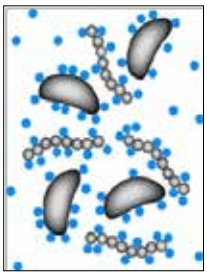
Laser Assisted Photo Dynamic Therapy looks like an exciting option as far as the future of adult and pediatric root canal disinfections are concerned however Further long term studies are needed to further evaluate and understand its extent of effectiveness in clinical practice.

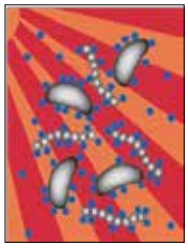














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