



Photo-Activated
Oral Disinfection

The Scientific Evidence



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Burns T, Wilson M, Pearson G J
Sensitisation of cariogenic bacteria to killing by light from a helium-neon laser. J. Med. Microbiol – Vol. 38, 1993; 38: 401-405

Summary:
Suspensions of the cariogenic bacteria Streptococcus mutans, S. sobrinus, Lactobacillus casei and Actinomyces viscosus were exposed to light from a 7.3mW helium-neon laser in the presence of toluidine blue O. A substantial killing rate (c. 10^6 cfu) of all four species was achieved with a dye concentration of 50µg/ml and a light energy dose of 33.6J/cm². This was achieved in 60s, an exposure time that is clinically acceptable. Exposure to laser light in the absence of the dye did not significantly affect the viability of any of the organisms. This approach may be useful in dentistry to sterilise a carious lesion prior to its repair.

Burns T, Wilson M, Pearson G J
Killing of cariogenic bacteria by light from a gallium aluminium arsenide diode laser. J Dent. 1994; 22: 273-278

Conclusion:
Suspensions of S mutans, S sobrinus, L casei and A viscosus were exposed to light from a GaAlAs laser in the presence of Aluminium disulphonated phthalocyanine and numbers of survivors determined. The kills attributed to lethal photosensitisation amounted to approximately 10^6 cfu for each organism. These kills were achieved within clinically acceptable time implying that lethal photosensitisation may be a useful technique in eliminating bacteria from a carious lesion prior to restoration.

Burns T, Wilson M, Pearson G J
Effect of dentine and collagen on the lethal photosensitisation of Streptococcus mutans. Caries Res. 1995; 29: 192-197

Conclusion:
Effective killing of 10^7 cfu S mutans was achieved with a range of energy densities using both HeNe and GaAlAs lasers after passage of the light through demineralised dentine discs using two photosensitisers Toluidine Blue O and AIPcS. Similar kill levels were observed when S mutans was suspended in a collagen matrix prior to exposure to the photosensitiser and light. The results imply that lethal photosensitisation may be effective at killing S mutans in a carious lesion even when the organism is suspended in demineralised dentine.

Wilson M, Burns T, Pratten J, Pearson G J
Bacteria in supragingival plaque samples can be killed by low-power laser light in the presence of a photosensitiser. Journal of Applied Bacteriology 1995; 78: 569-574

Conclusion:
Samples of dental plaque were treated with either Toluidine Blue O or AIPcS and irradiated with various energy densities of light from HeNe or GaAlAs laser respectively. The HeNe/Toluidine Blue O combination appeared to be more effective producing a log₁₀ reduction of 2.95, 5.4 and 3.34 in total anaerobic counts, Streptococci and Actinomyces respectively. This suggests that, if effective in vivo, photosensitisation may be useful as a means of eliminating plaque bacteria from a carious lesion.

Williams J A, Pearson G J, Colles M J, Wilson M
The effect of variable energy input from a novel light source on the photo-activated bactericidal of toluidine blue O on Streptococcus mutans. Caries Res 2003; 37: 190-193

Summary:
The study examined the effect of variable energy doses of light at 635nm from a novel delivery system using a 100mW diode laser and a photosensitiser. The system killed up to 10^9 cfu/ml S mutans in planktonic solution. The antibacterial action was directly proportional to the energy doses rather than power output. Energy dose of 1.8J killed 10% of bacteria present. Bacteria could be killed to significant levels within 30 seconds.

Lee M T, Bird P S, Walsh L J
Photo Activated Disinfection of the root canal: a new role for lasers in endodontics. Australian Endodontic Journal 2004; 30: 93-98

Conclusion:
In vitro studies of the use of low level laser light in conjunction with a photosensitiser to kill oral bacteria in the root canal have been encouraging. The utility of PAD in contemporary endodontics related to its potential for one step high level disinfection of the root canal space, as a prelude to single visit endodontics or as a refractory treatment of root canal infection. In the latter PAD could be used as an additional regimen in the eradication of persistent endodontic infection for which conventional methods have been unsuccessful. Clinical trials underway will determine whether PAD is useful in these applications.

The use of low level laser therapy has advantages in that the bactericidal effect of PAD can be achieved without damage to the host tissue and with little optical danger to operator and patient. Additionally the hardware is inexpensive compared with high power lasers. The PAD technique is simple to undertake since the photosensitiser solution can be applied directly into the root canal system and the laser energy delivered using an optical fibre with a diffuser.

Williams J A, Pearson G J, Colles M J, Wilson M
The photo-activated antibacterial action of toluidine blue O in a collagen matrix and in carious dentine. Caries Res 2004; 38: 530-536

Summary:
Effective killing of S mutans imbedded in a collagen matrix was achieved using a photosensitiser TBO [10µg/ml] in conjunction with a 100mW 635nm diode laser with the light delivered via an isotropic tip. The results showed that Photo-Activated Disinfection can achieve appreciable kills of oral bacteria including S mutans when the organisms are embedded in a collagen gel or present in carious teeth.

Pearson G J, Bonsor S J
Improved Restoration in Caries and root canals using a novel disinfection technique. As published in Dentistry, Oct. 2004, revised March 2005 to include most recent information

Conclusion:
In dental caries the use of PAD can eliminate residual bacteria in softened dentine and provide an environment which encourages rapid healing. This has led to its use in minimally invasive techniques In endodontics, despite following clinical “best practice,” 20% of canals remained infected after conventional chemo-mechanical treatment. The use of PAD as the disinfectant in conjunction with a cleanser such as citric acid rendered these canals bacteria free. Early indications of follow ups are favourable with strong evidence of peri-radicular healing in all cases.

Williams J A, Pearson G J, Wilson M, Colles M J
Antibacterial action of Photo-Activated Disinfection (PAD) used on endodontic bacteria in planktonic suspension and in artificial and human root canals. J Dent. In press.

Conclusion:
PAD killed endodontic bacteria at statistically significant levels compared to controls. Kills varied with bacterial species.

Bonsor S J, Nichol R, Reid T M S, Pearson G J
Microbiological evaluation of Photo-Activated Disinfection in endodontics (An in vivo study). British Dental Journal 2006; 200: 337-341

Conclusion:
The results of the study show that the PAD technique was successful in eliminating all the culturable bacteria when the correct combination of photosensitiser and energy dose are used and where both the light and the photosensitiser reach the bacteria. It highlighted the need for care in the use of the emitter to ensure that it is not bent too tightly or trapped in the canal.

Bonsor S J, Nichol R, Reid T M S, Pearson G J
An alternative regimen for root canal disinfection. British Dental Journal. In press.

Conclusion:
Within the limits of the current study, the use of an alternative means of root canal disinfection to sodium hypochlorite has been shown to be more effective at reducing or eliminating bacterial load in the canals.

Bonsor S J, Pearson G J
Current clinical applications of Photo-Activated Disinfection in restorative dentistry. Dental Update 2006; 33(3): 143-153

Summary:
Photo-Activated Disinfection has been successfully used in operative dentistry as a means of disinfecting residual softened caries where exposure is likely. This results in the removal of less tooth tissue and may improve the prognosis of treatment. In endodontics, PAD provides a means whereby canals can be effectively disinfected. This suggests that the dental surgeon can be confident that micro-organisms can be effectively killed prior to obturation and restoration. PAD has other potential applications and further ongoing research work is currently being conducted prior to its extrapolation to the clinical situation.

Lambrechts P, Huybrechts B, Moisiadis P, Bergmans L,
Mattar D, Teughels W, Pauwels M, van Meerbeek B &
Quirynen M
Photo Activated Disinfection; paintball endodontics
Roots 2007 2:28-43

Conclusion:

Although extensive consistent evidence is not yet available,
PAD seems to have a high potential for disinfection of root
canals. Mandatory to beneficial use of adjunctive PAD
treatment, all steps in routine endodontic treatment should
be followed carefully.

PAD does not replace shaping, cleaning and smear layer and
biofilm management. but can go hand in hand with routine
endodontic treatment to improve outcome. This is consistent
with minimally invasive endodontics

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