

Photodynamic Therapy In Oral Lesions

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Abstract: Photodynamic Therapy (Pdt) Is An Anticancer Combination Therapy, Which Requires A Photosensitizer, That Tends To Accumulate Preferentially In The Tumor And A Light Sources¹. Historically Large, Complex Lasers Have Been Used To Carry Out Pdt Treatment. Nowadays There Is A Wide Range Of Coherent And Non-Coherent Sources That Can Be Used. This Paper Considers The Important Characteristics Of Light Sources For Pdt, Including Dye Lasers Pumped By Argon Or Metal Vapors And Frequency-Doubled Nd: Yag lasers. Non-Lasers Sources Including Tungsten Filament, Xenon Arc, Metal Halide And Fluorescent Lamps Are Also Discussed. New Exciting Developments Such As Leds And Femtosecond Lasers Are Also Reviewed. The Relative Merits Of Lasers And Non-Lasers Are Critically Examined.

Keywords: Photosensitizer, Oxygen, Light Source, Photon

1. INTRODUCTION:

Photodynamic Therapy (Pdt) Is An Anticancer Combination Therapy, That Requires A Photosensitizer, Which Tends To Accumulate Preferentially On The Tumor Site And A Light Source For Activation Of The Photosensitizer¹. Photodynamic Therapy (Pdt) Is A Light Induced Inactivation Of Cells, Microorganisms, Or Molecules². Jodlbaner And Von Tappeinerin 1904 Coined The Term Photodynamic For Explaining Oxygen Dependent Chemical Reactions Resulting From Photosensitization That Causes Bacterial Deactivation. In 1999, Us Food And Drug Administration Approved For The First Time The Pdt For The Treatment Of Precancerous Skin Lesions On The Face Or The Scalp. Pdt Includes The Use Of A Photosensitive Agent Or Photosensitizer (Ps) And A Specific Wavelength Of Light Source. The Pss That Are Used In Pdt Are Chemical Compounds Which After Absorption Of Light Are Capable Of Being Promoted To An Excited State. The Ps Is Either Applied Topically Or Through Intravenous injection, Which Depends On Its Type And Concentrates Mainly In Abnormal Or Neoplastic Cell².

Types Of Photosensitizers:

- 1-Dyes
- 2-Chlorines
- 3-Porphyrines
- 4-Xanthenes
- 5-Monoterpene

Components Of Photodynamic Therapy^{3&4}

The Components That Are Involved In Photodynamic Therapy Are-

- 1-Photosensitizer
- 2-Oxygen
- 3-Light Source

Mechanism Of Photo Dynamic Therapy

In Photo Dynamic Therapy Absorption Of Light By Photo Sensitizer Initiates Chemical Reactions That Produces Transient Phototoxic Compounds¹. Photodynamic Mechanisms Proceed From The First Excited Single State(S_1) Of The Photosensitizer Produced By The Absorption Of A Photon.From Single State (S_1) The Molecule Either Loses An Electron To Originate A Radical Cation (Ps)Or Quickly Relaxes Into The First Excited Triplet State T_1 . Both Ps And T_1 Have A Relatively Long Lifetime And Can Interact With Oxygen Molecules To Generate Highly Reactive Compounds Such As Peroxides And Singlet Oxygen. The Species Thus Produced Are Very Reactive And Can Induce Oxidative Stress Of The Cell Leading To Consequent Cell Deathor Necrosis¹.

Photodynamic Reaction³

The Reaction Can Be Explained As Follows: -

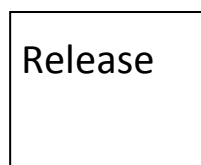
Light



Photosensitizer



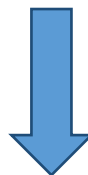
Activated Photosensitizer + O_2



Reactive

Oxygen

Species



Acts On Tumour And Microorganisms

*The Light Sources For Pdt Can Be Either Laser Or Non-Laser⁵.
 The Lasers That Can Be Used For Photodynamic Therapy Are Classified As Follows.*

1-Gas Laser

- Argon
- Carbon-Dioxide

2-Liquid

- Dyes

3-Solid

- Neodymium Yttrium Aluminum Garnet
- Erbium Yttrium Aluminum Garnet
- Diode

4-Semiconductor

- Hybrid Silicon Laser

The Detailed Wavelengths, Bandwidth, Irradiance, Pulse Duration & Light Delivery Of The Various Lasers Can Be Tabulated As Follows ^{1& 6,7}

	Wavelength(S)	Bandwidth	Irradiance	Pulse Duration	Light Delivery
Argon Laser	488 And 514.5nm	Monochrome	0.5-1 W/Cm ²	Continuous Wave	Direct Or Optical Fibre
Dye Laser Pumped By Argon Laser	500- 750nm	5-10nm	10-200w/Cm ²	Continuous Wave	Direct Or Optical Fibre
Metal Vapour Laser	Uv Or Visible	Monochrome	Up To 10w/Cm ²	10-50ns Quasi Continuous Wave	Direct Or Optical Fibre
Dye Laser Pumped By Metal Vapour Laser	500-750nm	5-10nm	10-500mw/Cm ²	10-50nsquasi Continuous Wave	Direct Or Optcalfibre
Dye Laser Pumped By Solid State Laser	For A Nd: Yag 1064,532,355,266nm	Monochrome	Up To 10w/Cm	10ps-30ns Quasi Continuous Wave	Direct Or Optical Fibre
Solid State Optical	400-750 Nm	5-10nm	10-500mw/Cm ²	10ps-30ns Quasi Continuous Wave	Direct Or Optical Fibre

Parametric Oscillator	250-2000nm	Monochrome	Up To 1w/Cm ²	10ps-30ns	Direct Or Optical Fibre
Semi-Conductor Diode Lasers	600-950nm	Monochrome	Up To 700m W/Cm ²	Continuous Wave	Direct Or Optical Fibre

The Advantages & Disadvantages Of The Commonly Used Various Lasers Are⁶:

1. Carbon Dioxide Lasers: (Gas Lasers)

Advantages-

- Have High Affinity For Water, Rapid Soft Tissues Removal.
- Rapid Hemostasis With Shallow Penetration.
- Generally Used In Surgical Procedures Both Major And Minor.
- Improves Mechanical Retention Of Sealant

Disadvantages-

- Have The Highest Absorbance Of Any Laser
- Large Size, High Cost
- Greater Hard Tissue Destruction

2. Neodymium- Yttrium Aluminum Garnet Laser: Solid State Lasers

Advantages

- Highly Absorbed By Pigmented Tissues.
- Effective For Cutting And Coagulating Dental Soft Tissues
- Good Hemostasis
- Used In Non-Surgical Sulcular Debridement

Disadvantages

- High Cost And Size

3. Erbium Laser: Solid State Laser

Advantages

- Erbium Wavelengths Have A High Affinity For Hydroxyapatite And The Highest Absorption Of Water
- Used For Both Soft And Hard Tissues

Disadvantages

- High Cost
- Marginally Prolonged Treatment Time But Better Results

4. Diode Lasers Solid State Lasers

Advantages

- Engrossed Primarily By Tissue Pigment And Hemoglobin
- Used For Soft Tissue Applications

Disadvantages

- Poorly Absorbed By The Hydroxyapatite And Water Present In The Enamel

5. Argon Lasers

- Yield High Intensity Visible Blue Light
- Curing Of Dental Restoration
- It Also Changes The Surface Chemistry Of Both Enamel And Root Surface Dentine Which Reduces The Probability Of Recurrent Caries

- Removes Extrinsic And Intrinsic Stains
- Bleaching Of Teeth

6. *Erbium Chromium Yttrium Scandium Gallium Garnet Laser*

- Etches Enamel Surface
- Removal Of Smear Layer

7. *Erbium Yttrium Aluminum Garnet Laser*

- Removes Caries In Enamel And Dentin
- Removal Of Dislodged Gic And Composite
- Desensitizes The Hypersensitivity Dentine

The Non-Lasers I.E.(Lamps) That Can Be Used For Photodynamic Therapy Can Be Tabulated Based On Wavelength, Bandwidth, Irradiance & Light Delivery As Follows¹

	Wavelength(S)	Bandwidth	Irradiance	Light Delivery
Tungsten Filament	400-1100 Nm	10-100 Nm (Depending On Filters Used)	Up To 250 Mw/Cm ² Or Typically Up To 1.8mw/Cm ² /Nm	Direct Or Via Liquid Light Guide
Xenon Arc	300-1200 Nm	10-100 Nm (Depending On Filters Used)	Up To 300mw/Cm ² Or Typically Upto 3mw/Cm ² /Nm	Normally Liquid Light Guide
Metal Halide	Depending On The Metal, Lines Between 250-730 Nm (Can Be Phosphor Coated)	10-100 Nm (Depending On Filters Used)	Up To 250mw/Cm ² Or Typically 1.2mw/Cm ² /Nm	Direct Or Liquid Light Guide
Sodium (Phosphor Coated)	590-670 Nm	10-80 Nm (Depending On Filters)	Up To 100mw/Cm ²	Direct Illumination
Fluorescent	400-450 Nm	Approximately 30 Nm	Up To 10 Mw/Cm ²	Direct Illumination

2. CONCLUSIONS:

Pdt using Various Photosensitizers Can Produce Consistent Epithelial Necrosis With Excellent Healing. The Targeted Organ, Photosensitizer, Reliability Of The Photosensitizer, Ease Of Use And Various Light Sources Are The Most Important Variables That Need To Be Considered In A Clinical Setting. In The Past Decade There Had Been Renewed Interest In The Development Of Both Laser And Non-Laser Light Sources For Pdt.

Ethical Clearance – Not Required Since It Is A Review Article

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Conflict Of Interest – Nil

3. REFERENCES:

- [1] H.Moseley Laser And Non-Laser Sources For Photodynamic Therapy Lasers Med Sci2002; 17: 173-186.
- [2] Andreadis Dimitriosphotodynamic Therapy For The Management Of Oral Potentially - Malignant Disorders And Oral Cancer Translational Research In Oral Oncology 2016; 1: 1-19.
- [3] K.Ramya Photodynamic Therapy In Oral Diseasesint J Biol Med Res 2012; 3(2): 1875-1883.
- [4] K.Konopka And T.Goslinskiphotodynamic Therapy In Dentistry J Dent Res 2007; 86 (8):694-707.
- [5] Alexander Maninagal Luke Lasers A Review With Their Applications In Oral Medicine. J Lasers Med Sci 2019 ; 10(4):324-329.
- [6] Chaitanya Pendyalacontemporary Apprise On Lasers And Its Application In Dentistry Tiwari Rvc 2017;4(2):47-51.
- [7] Thomas S. Mang Lasers And Light Sources For Pdt; Past, Present And Futurephotodiagnosis And Photodynamic Therapy 2004;1:43-48.