Laser-Assisted Endodontics

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Introduction

- The primary goal of RCT eliminate MO from RCsystem &radicular
- Laser can assist in the diagnosis of MO, to inactive O through a range of thermal, PD & PM processes.
- Unlike conventional methods laser effects reach across the entire RCS and penetrate into DT
- The use of lasers, in many cases combined with appropriate fluids, can assist in achieving the goals of 3D cleaning and profound disinfection of the canal.

Primary application	Examples
Diagnosis	Detection of pulp vitality Doppler flowmetry Low-level laser therapy (LLLT) Laser fluorescence Detection of bacteria
Pulp therapy	Pulp capping Pulpotomy
Canal preparation	Biomechanical preparation Removal of smear layer Sterilization of the root canal High-level lasers – photothermal disinfection Low-level lasers –photodynamic disinfection
Periapical surgery	Ablation of granulation tissue Bone cutting and root resection
Laser photobiomodulation	Laser-induced analgesia Accelerated healing after pulpotomy or periapical surgery
Other	Removal of root canal filling materials and fractured instrument Softening gutta-percha Removal of moisture/drying of canal

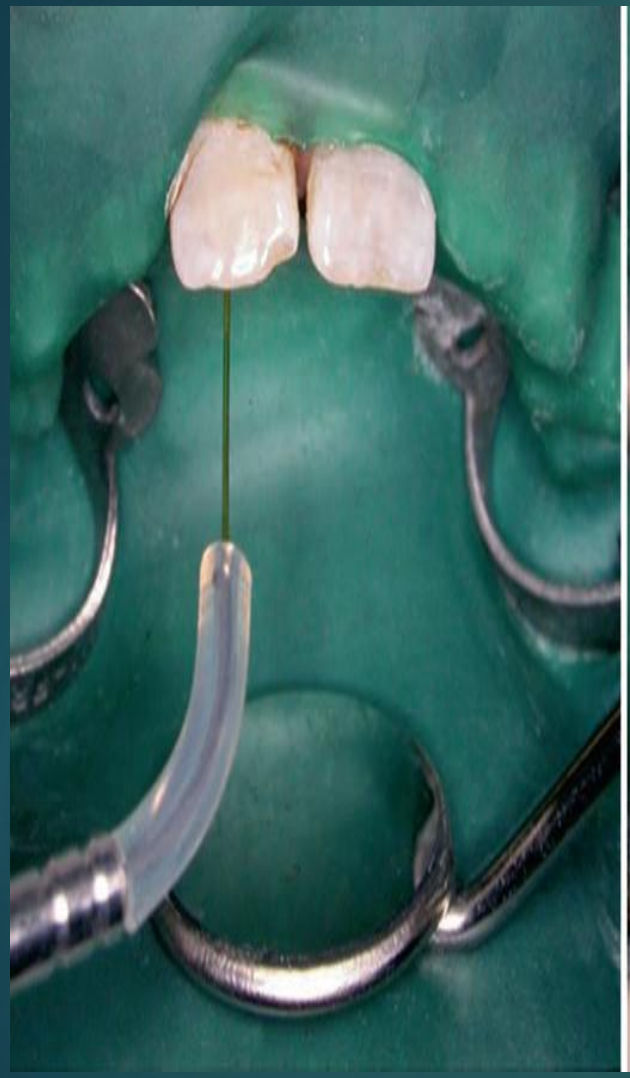
Laser	Wavelength	Reported uses in endodontics
Short wavelength	Argon 488–514.5 nm	Endodontic disinfection
	KTP 532 nm	Soft tissue surgery in endodontics, endodontic disinfection
	He-Ne 633 nm Diode 635 nm	Doppler flowmetry, photoactivated disinfection of root canals
	Diode 810–980 nm	Soft tissue surgery in endodontics, endodontic disinfection, laser-induced analgesia, laser photobiomodulation
	Nd:YAG 1064 nm	Soft tissue surgery in endodontics, endodontic disinfection, biomechanical preparation
Long wavelength	Ho:YAG 2100 nm	Tooth preparation, soft and hard tissue surgery in endodontics, endodontic disinfection, biomechanical preparation
	Er,Cr:YSGG 2780 nm	Tooth preparation, soft and hard tissue surgery in endodontics, endodontic disinfection, biomechanical preparation
	Er:YAG 2940 nm	Tooth preparation, soft and hard tissue surgery in endodontics, endodontic disinfection, biomechanical preparation
	Carbon dioxide 10,600 nm	Pulp capping; soft tissue surgery in endodontics

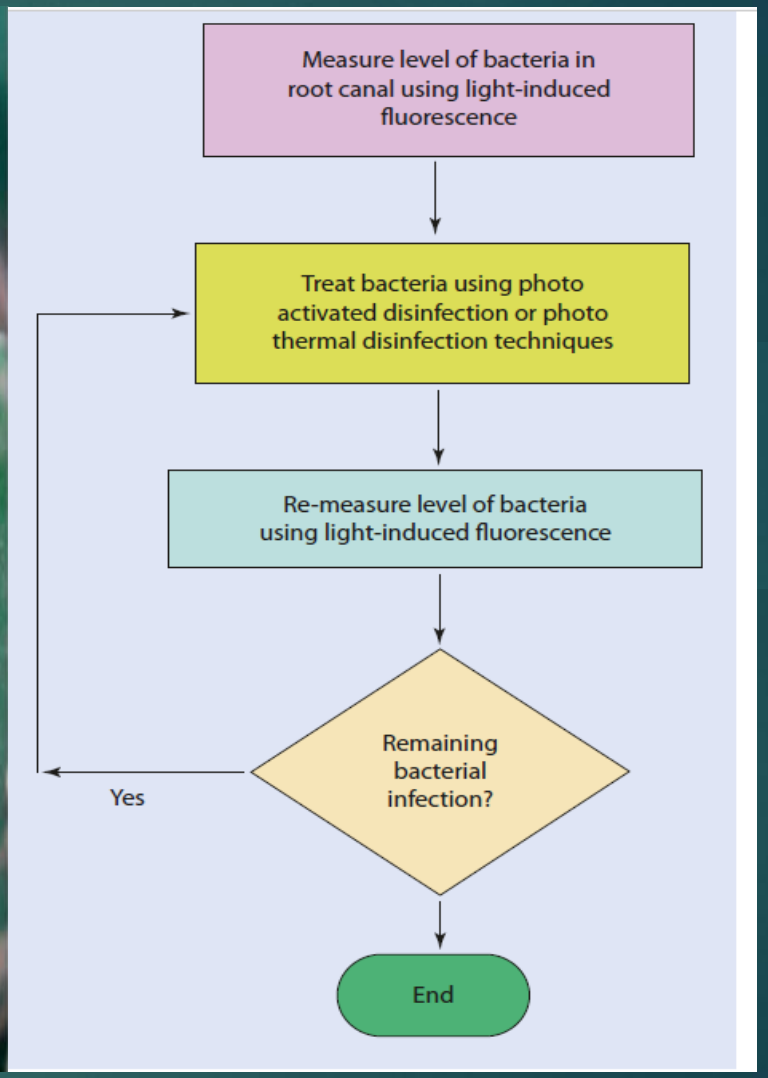
Laser Doppler Flowmetry

- During pulp testing, a pain response elicited provides information about pulpal sensory supply, but not about its blood supply.
- false results can lead to unnecessary endodontic treatment.
- In LDF, laser is transmitted through tooth to pulp by fiber optic probe If vital, blood flow will be
- movement of erythrocytes > scattered light is frequency-shifted, whilst light reflected from static tissue is un-shifted.
- While LDF is regarded as a "gold standard," prone to interferences
- There also work to explore the applications of transmitted laser light

Fluorescence Diagnosis of RCS

- Traditional culture-based techniques for assessing the presence of MO in RCT are difficult to use and prone to error.
- DIAGNOdent (655 nm) elicit fluorescence emissions in near-IR
- The fluorescence properties of bacterial cultures, mono-species biofilms in root canals, pulpal soft tissues, and sound dentin
- factors which could impair the fluorescence process, quenching fluorescence emissions (H_2O_2, O_3) > false negative signals
- Tetracyclines medicament pastes > false-positive signals



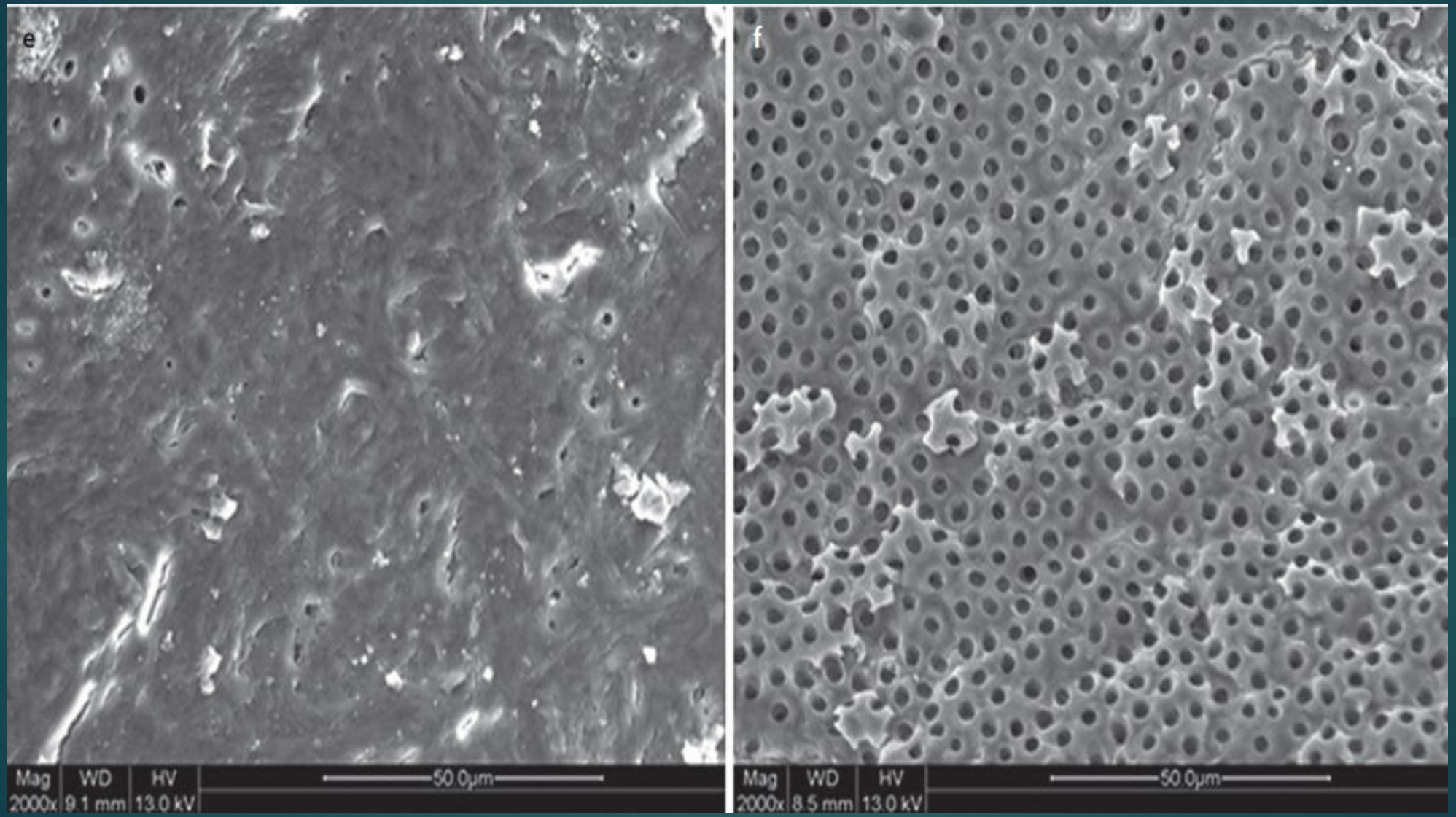

Measure level of bacteria in root canal using light-induced fluorescence
Treat bacteria using photo activated disinfection or photo thermal disinfection techniques
Re-measure level of bacteria using light-induced fluorescence
Remaining bacterial infection?
Yes
End

Laser-Assisted Widening of the Root Canal

- Laser wavelengths should ablate hard tissue for maximum effectiveness.
- Thermal side effects need to be controlled.
- Special tip designs improve safety and effectiveness.
- Suitable wavelengths are in the middle infrared.
- Laser energy must be pulsed to ensure thermal stresses are reduced.
- Concurrent irrigation assists cooling.

Removal of Smear Layer from Root Canal Walls

- Laser should absorb strongly in water *to* generate cavitation.
- pulsed modes is essential with Laser limited pulse energy
- Water-based irrigant fluids, never be done dry.
- Laser activation enhances the action of EDTA in SL removal.
- Special tip designs improve safety and effectiveness.
- Concurrent irrigation assists cooling.


e
Mag
2000x
WD
9.1 mm
HV
13.0 kV
50.0µm
f
Mag
2000x
WD
8.5 mm
HV
13.0 kV
50.0µm

Photothermal Disinfection

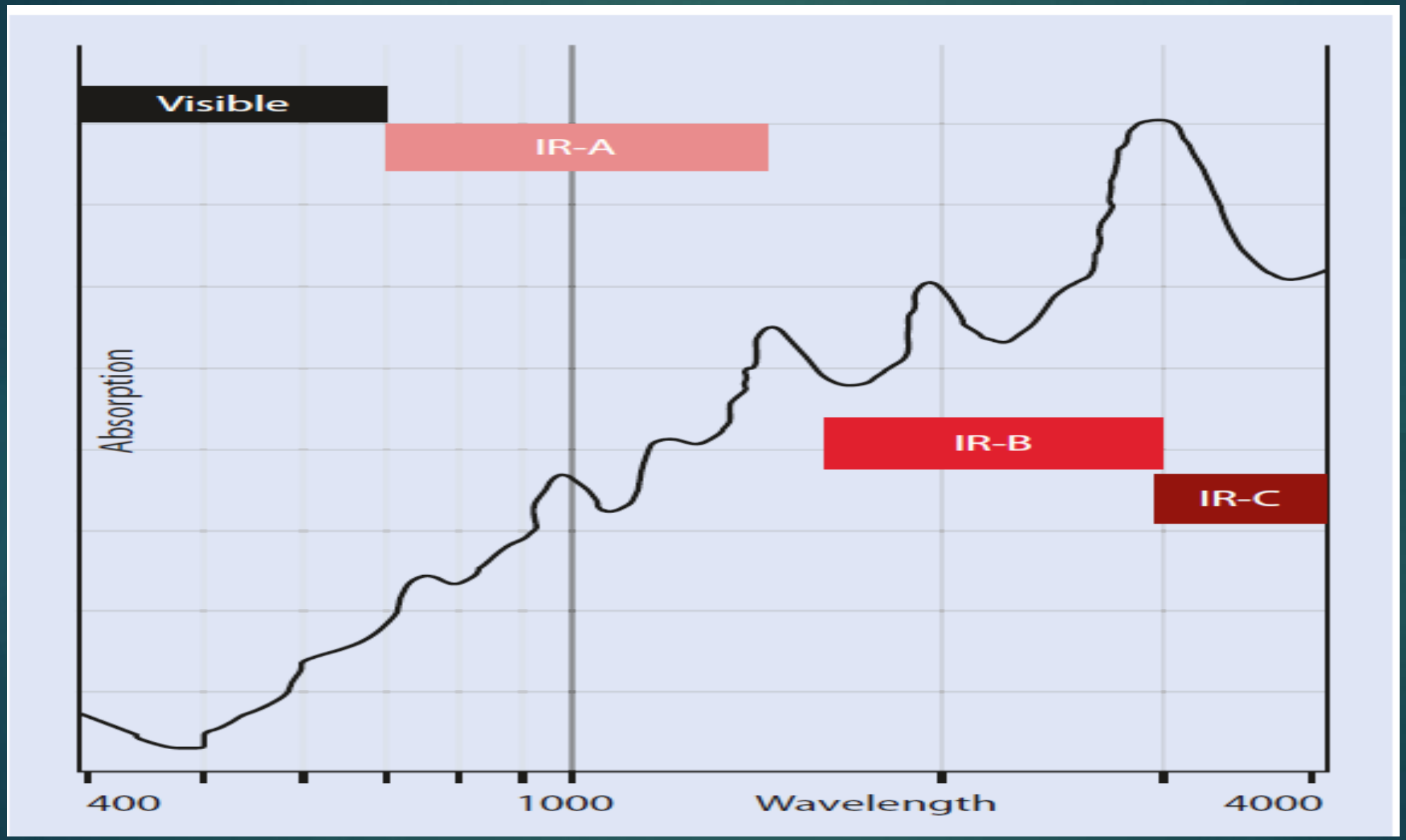
- Laser energy must absorb into major chromophores (water, porphyrins, melanin and other pigments) for bacterial inactivation to occur.
- Nd:YAG, KTP, and near-infrared diode lasers. also Middle-infrared lasers
- Lateral-emitting/side-firing tips are preferred to ensure even irradiation is achieved.
- Pulsed modes > lower thermal stress
- Movement of the fiber enhances coverage of the walls.

Photodynamic Disinfection

- Laser energy must absorb into the photosensitizer
- Visible or near-infrared laser system, Preferred lasers are visible red (633, 635, 660, 670 nm) when blue dyes are used (tolonium chloride and methylene blue).
- The liquid must be placed before laser activation
- Effective dye solutions will contain low levels of surfactants
- The dye used should not permanently stain teeth.
- Thermal effects caused by photoactivated disinfection are minimal.
- Lateral-emitting/side-firing tips are preferred

Fluid Agitation and Cavitation

- Water-based fluids such as EDTA are preferred.
- Optimal lasers are the middle-infrared lasers Pulsed modes must be used
- Absorption leads to cavitation and thus to agitation,fluid movement and shockwaves.
- Irrigation between lasing cycles reduces thermal stress.
- Excessively high pulse energies can cause fluid extrusion through the apical foramen and when the apical foramen is larger
- A small volume of water will show greater cavitation
- Lateral-emitting/side-firing tips are preferred as this changes the direction of cavitation bubble formation and collapse.


Visible
IR-A
IR-B
IR-C
Absorption
400
1000
Wavelength
4000

Laser-Enhanced Bleaching

- Photo-thermal laser bleaching requires careful control of the irradiation protocol to limit heat stress to the dental pulp.
- Photodynamic laser bleaching is effective for more challenging intrinsic stains including tetracyclines deposited during tooth formation and sclerosed vital teeth.
- External bleaching approaches overcome problems of invasive cervical resorption associated with internal bleaching (walking bleach) methods where peroxides can come into contact with periodontal tissues.

Laser-Induced Analgesia and Photobiomodulation

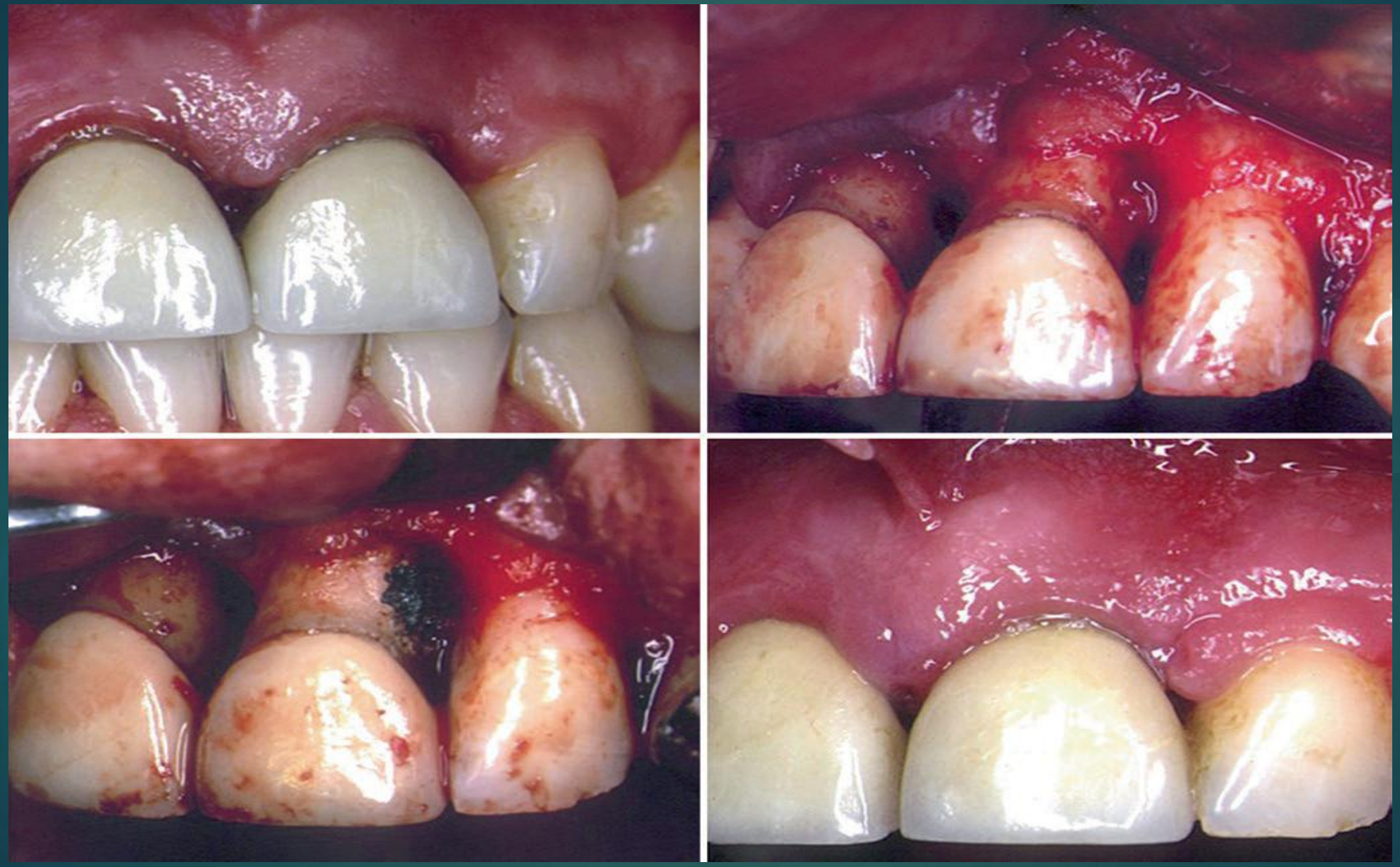
- Analgesic effects can be induced with near- or middle-infrared lasers.
- Irradiation parameters for analgesia with diode lasers are higher than those for enhancement of wound healing and other photobiomodulation treatments with the same lasers.
- Laser-induced analgesia effects occur when lasers are used to treat hypersensitive cervical dentin

Pulp Therapy and Pulpotomy

- Laser energy must absorb into major chromophores (water, porphyrins, melanin and other pigments) for coagulation and bacterial inactivation to occur
- Can be done with almost any laser system, but preferred lasers are Nd:YAG, KTP and near-infrared diode lasers.
- If middle-infrared lasers are used, long pulse durations are needed to maximize coagulation
- Typically employs very short exposure times
- The techniques to treat the exposed pulp stumps are the same as for direct pulp capping

Endodontic Surgery and Treatment of Resorption Lesions

- Laser energy must absorb into major chromophores (water, porphyrins, melanin and other pigments) for soft tissue ablation to occur
- Can be done with almost any laser system, but preferred lasers are Nd:YAG, KTP and near-infrared diode lasers. With the carbon dioxide laser, extreme care is needed to avoid deleterious thermal changes to tooth structure and the dental pulp.
- Hard tissue ablation (bone cutting, root-end resection) requires a middle-infrared laser for high cutting efficiency.



Safety Issues Related to the Use of Lasers in Endodontics

- Lasers can used with endo equipment ex: operating microscopes
- Fluid fed around the laser to cool it during surgery must be sterile.
- Deposits of carbonized tissue reduce quantity & quality of emission.
- 5.5 °C can promote necrosis of 15% of cases, while temperature increases of 11 and 17 °C will cause necrosis in 60 and 100% of cases
- The periodontal apparatus is known to be sensitive to 47 °C, while >60 °C will permanently stop blood flow and cause bone necrosis
- A threshold temperature is <7 °C
- (TR) the amount of time required for heat to flow into adjacent regions or otherwise be dissipated

Thank you