Lasers in Endodontics

DCP4, Semester 1
Lecture7

Dr Sheela B Abraham
B.D.S., M.D.S

LASER

LIGHT AMPLIFICATION by STIMULATED EMISSION of RADIATION

What is laser?

A laser is a device which transforms light of various frequencies into a chromatic radiation in the visible, infra-red and ultra-violet regions with all the waves in phase capable of mobilising immense heat and power when focussed at close range.

Properties of Laser light

- It is collimated –travels in a single direction with very little divergence even over long distances
- It is monochromatic- consists of one colour or a narrow range of colours
- It is coherrant-light waves move in phase together in both time and space

Classification

- Based on wavelength

  -Soft laser

  -Hard laser

- Based on lasing medium

  -Solid-eg.NdYAG(Neodynium Yttrium Aluminium Garnet), Diode

  - Liquid-eg Dye

  -Gas –eg. CO2, Argon, ErYAG(Erbium Yttrium Aluminium Garnet)

- Based on mode of use

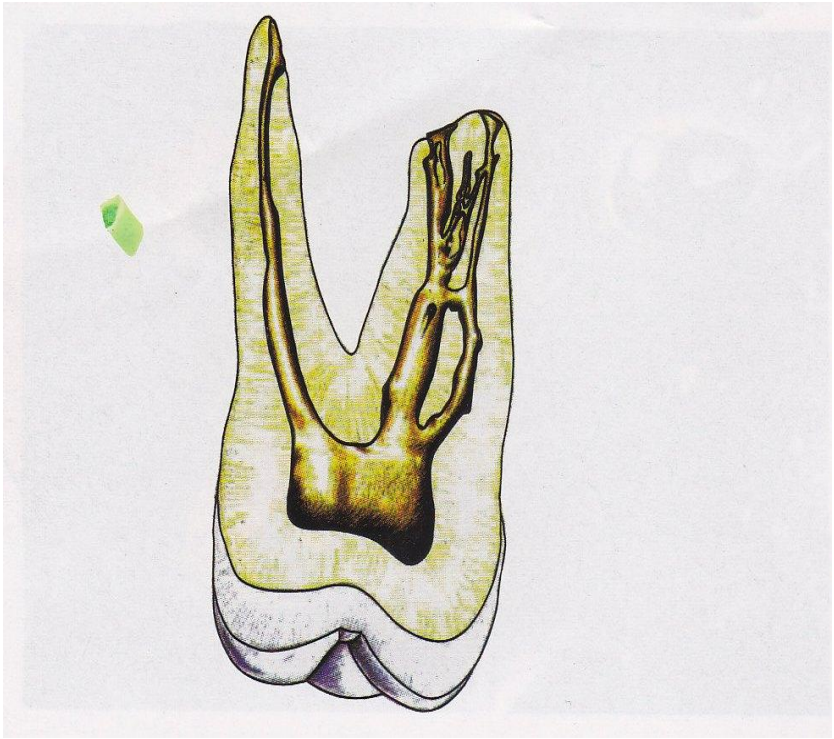
  -Non contact-eg CO2

  -Contact focussed- eg Argon,Ho:YAG(Holmium Yttrium Aluminium Garnet

  -Non-contact defocussed eg NdYAG

Anatomic complexities

- Macro-anatomy is very complex
- Greatest anatomical variations seen in the apical 3rd-
- Studies show number of dentinal tubules remain constant throughout life but lumens of tubules decrease in diametre upto complete obliteration
- 1-12 species of bacteria found in the rootcanal

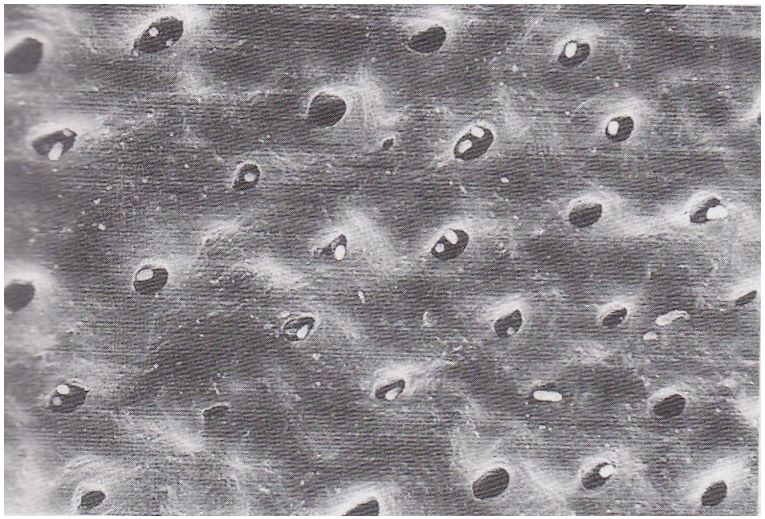


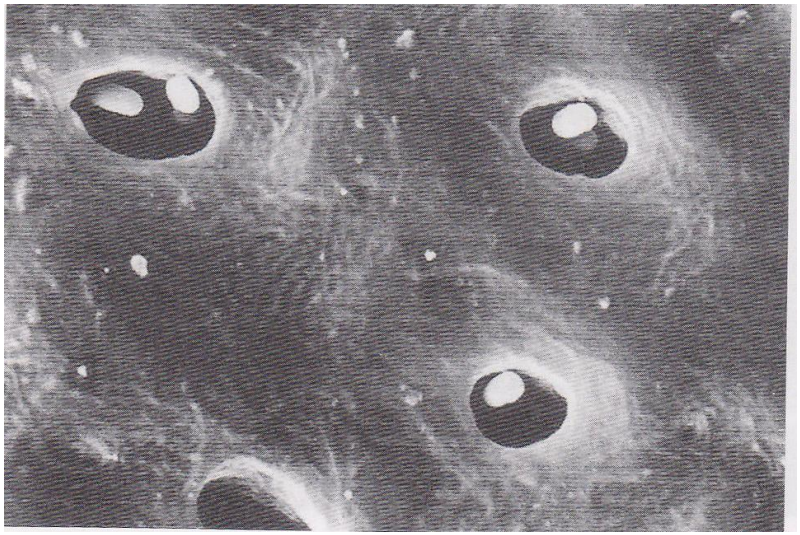
Reaction of bacteria to laser light

- Under laser light, both biological tissues and individual cell systems change their structure

- Laser radiation has a bactericidal effect by causing changes in the bacterial cell wall

SEM pictures of bacteria penetrating into the dentinal tubules





Application of laser in endodontics

- **Diagnosis**: Laser Doppler Flowmetry

HeNe (helium-neon) with wavelength of 632.8nm and GaAl (galium aluminium) with wavelength of 780-820nm at power of 1-2 mW is used .

Principle: Changes in the RBC flux in pulp tissue will help differentiate between vital and non-vital pulp. Specifically used to check vitality of immature teeth, traumatised teeth etc

- **Dentinal hypersensitivity**

Lasers now provide reliable and reproducable treatment with success rates upto 90%.

Low output power lasers: He-Ne, Ga-Al-Arsenide

Middle output power lasers: NdYAG, CO_2

- **Pulpcapping and pulpotomy**

Mainly used lasers are NdYAG and CO_2

Acheives haemostasis, facilitates pulpal healing after irradiation at 2W for 2 secs

- Modification of rootcanal wall

Usually used lasers are CO_2, NdYAG, ErYAG

- Rootcanal shaping

Er:YAG mainly used for shaping and preparation of the rootcanal. Has the ability to open the tubules completely and remove the smear layer in toto.

The ablative effect of the Er:YAG laser wavelength is seen.The ablative products and part of the smear layer is melted and recrystallised

- Recent advances in rotary instruments, hypochlorite, EDTA –all clean

- Smear layer and debris accumilation have remained constant
- Disadvantages of rinsing solutions is that their bacteriocidal effect remains in the canals-because of the narrow diametre of tubules and large surface tension of the solutions, they are unable to enter the tubule, only about 100 microns.
- By studies, it is shown the bacteria penetrate over 1000microns from the canal lumen, thus they are protected in the deeper layers of dentin and maintain their virulence.

Laser-assisted root canal sterilization

- Now use of laser assisted endodontic procedures is as standard therapy concepts
- Lasers in the near IR (infra red) range and only those wavelengths that can penetrate dentin to a depth that can eliminate bacteria are applicable
- The incident light is partly reflected and refracted, but its main propagation is scattering, that is the splitting of light by repeated directional diversion. So light emitted by the laser creates a light fog in the dentin and does not have a concentrated beam anymore.

Lasers commonly used in endodontics

- **Nd:YAG:**Best documented laser in literature for canal sterilisation. Another advantage of the Nd:YAG laser is that bacteria lying in clinical but not radiographically verified side canals,esp apical deltas can be reached by the penetration depth of the laser.

Nd:YAG laser because of its wavelength and pulsed action has the **highest bactericidal action** of all lasers currently available

Nd:YAG laser is also used to **modify the morphology** of the rootcanal-sealing effect on the root canal wall.With the melting of the rootcanal surface and the smear layer, a homogenous flat and recrystallised surface can be produced.The open tubules thus become closed and sealed

- **Diode Laser:** Its penetration depth is lower when compared with Nd:YAG ,also reduces the risk of unwanted temperature rise; which mean less efficiency in deeper lesions. It has a sealing effect on the tubules.

It has a bio-stimulative effect-it has been shown that diode laser stimulates cell proliferation and it shows an inhibiting effect on inflammation propagating enzymes

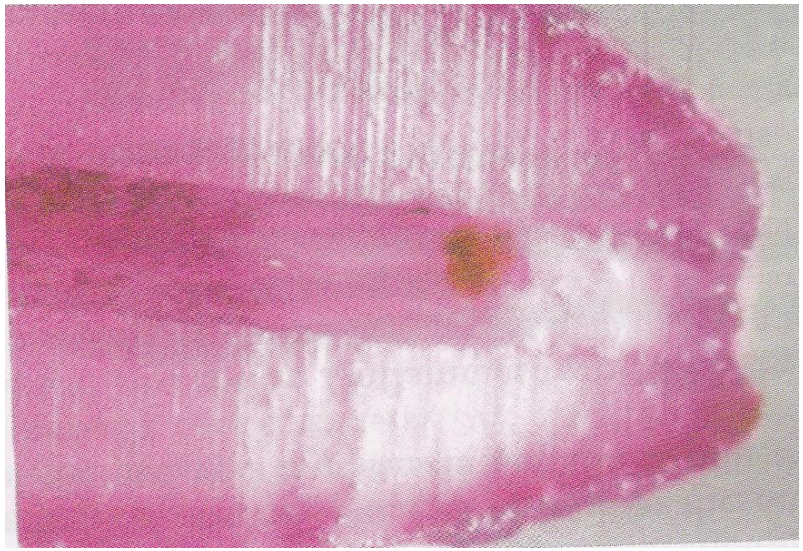
Er:YAG

- Not very suitable for rootcanal sterilisation

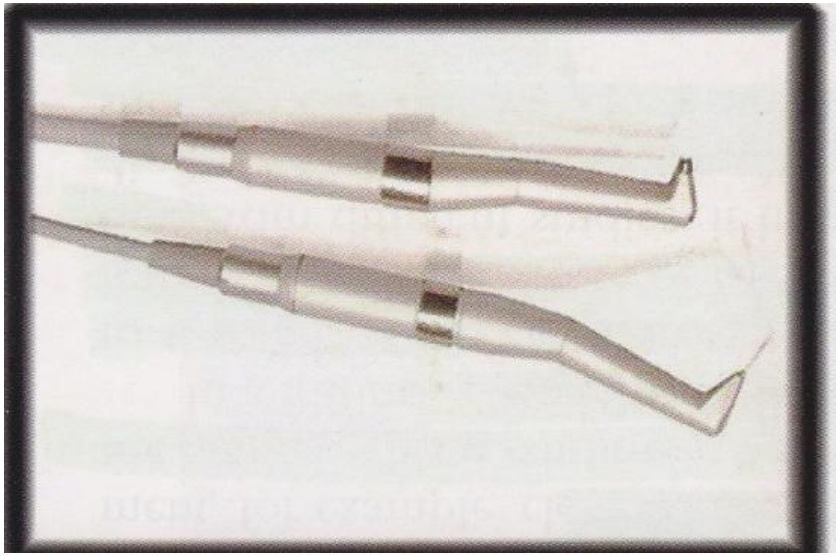
Is bactericidal effect through removal of the smear layer is comparable with chemical rinsing solutions.

When comparing the Nd:YAG and the Er:YAG laser actions, Er:YAG was able to produce bacterial reducing effect in dentin areas close to the rootcanal especially for radiation-sensitive E.coli but its effect was much lower than the Nd:YAG

Apex sealing



Different wavelengths are capable of sealing the surfaces and making them impermeable to bacteria and their toxins.
Apical sealing can be achieved by all ie Nd:YAG, Diode, Er:YAG .



Endodontic retreatment:

Objective of nonsurgical endodontic retreatment is to remove the infection from the RC space. NdYAG can be used to remove GP and broken files. Time taken to remove any filling material is reported to be shorter than conventional methods. ErYAG laser is used to remove ZnO euginol sealers

Apicoectomy

Attempts have been made to seal the apical foramina using laser and it has been found to have reduced permeability after laser application. This could be because of the structural changes in the dentin caused by lasing. ErYaG is preferred as it causes a bloodless field, has the ability to vapourize tissue and coagulate and seal small bloodvessels, cut dental hard tissue without significant thermal damage. Working time is less and diminished postoperative discomfort.

Indications for laser-assisted endodontics

- Chronic apical periodontitis
- Acute apical periodontitis
- Periapical abcess
- Apical resorption
- Therapy resistant long term failure cases
- Combined periodontal-endodontic pathology
- Partly sclerosed canals,where the apex is not reachable because of sclerosis

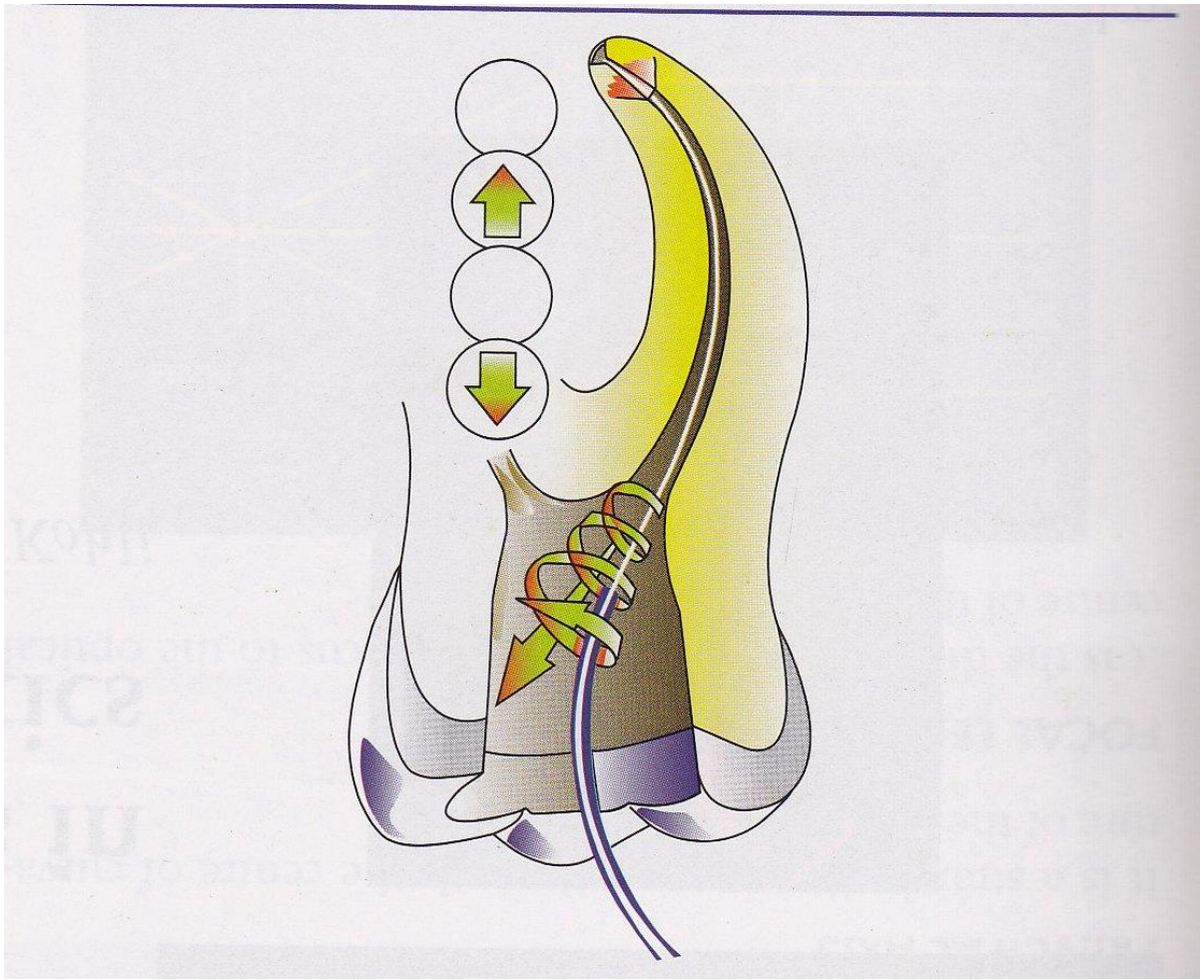
Procedure

- After conventional preparation, extensive rinsing and drying of the canal with paper points
- Laser fibre is inserted into the canal after marking with rubber stop
- Care should be taken that the fibre does not remain at the apical stop for more than 1 sec since temp. will rise to critical levels

- Fibre is pulled from apical to coronal in circular movements to cover the whole root dentin surface –procedure is repeated at least 5 times.

- After this, canal is filled with Ca hydroxide and sealed till the next appointment.

- Clinical experience has showed that 2 sessions are needed for optimum laser supported RCT. In some cases, the bacteria may actually increase after the 1st visit ,but after the 2nd session of irradiation, chemical sterilization is achieved.



- Bacteria that are irradiated with lower light intensities show cell-membrane damage,it has an effect on the survival of the bacteria.Their general resistance to changes to their envoirment is reduced and their sensitivities to chemical disinfection is increased.
- With numerous irradiations,a cumulative bacterial effect is reached.

Advantages of laser

- Painless
- Lesions treated by laser heal faster
- Create bloodless field and reduce the opportunity for blood-borne contamination
- Minimizes post-operative swelling, pain and scarring.

Disadvantages

- High cost of equipment
- Large size
- Need for complete knowledge of equipment, use and safety.

Laser Hazards and safety

Injury caused	Safety measure
Ocular injury-caused by direct emission or from reflected surfaces. affects sclera, retina and aqueous humour. Causes cataract formation	Personal protective equipment must be worn, protective eye wear with proper optical density to filter out that wavelength
Tissue hazards: Laser induced damage to skin, potential for mutagenic changes, - photodisruption, photoplasmolysis	Operator must be aware of absorption and depth of penetration of laser energy in the tissue.
Respiratory hazards: Potential inhalation of biohazardous material that may be released during surgical applications	Moistened drapes and gauze must be used, proper high evacuation of operative field and use of surgical masks
Fire and explosions: Flammable solids like clothing, paper products, plastics, liquids like ethanol, gases like nitrous oxide can be easily ignited if exposed to laser beam	Alcohol should be kept away from the area. Precautions should be taken.
Electrical hazards: Electric shock hazards and electric fire or explosion hazards	Precautions take to avoid water contact with electric cords and power supplies.


Thankyou !!