Ministry of Higher Education and
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Study the thermal effect of laser in dentistry

A Project submitted toCollege of Dentistry, University of Maysan, in Partial Fulfillment for the Degree of Bachelor of Dental Surgery (B.D.S.)

By

Hussein mared

Aqeel Jawad

Supervised by

Lecturer . Dr.Khitam ALsaedi

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Certification of the Supervisor

I certify that this project entitled

" Study the thermal effect of laser in dentistry

" was prepared by the fifth-year students Hussein mared and Aqeel Jawad under my supervision at the College of Dentistry/University of maysan

Supervisor Signature

Lecturer . Dr.Khitam ALsaedi

Dedication

With all love and loyalty and the kindest words of thanks and praise, and from hearts filled with brotherhood, I extend my thanks and praise for standing by my side in times of travel and hardship, and in distress and distress.

Acknowledgment

First of all, I thank "Allah" almighty for granting me the will and strength to accomplish this research and I pray that his blessings upon me may continue throughout my life.

I am indeed internally thankful to my supervisor

Lecturer . Dr.Khitam ALsaedi

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Abstract

Lasers in dentistry are used as a treatment tool or as an adjunct tool. By using the laser in the field of dentistry, the main goal is to overcome the disadvantages, which are currently being experienced in conventional dental treatment procedures. Many specialties in dentistry including oral surgery, implants, oral medicine, periodontics, pediatrics, and operative use the current new laser technology. The ability of lasers to provide minimally invasive procedures with less discomfort to the patient has been useful in the patient delivery system in dental practice

1-1- Introduction:

A tooth is a small, hard structure found in the mouths of vertebrates, including humans.

Teeth are primarily used for chewing and breaking down food into smaller pieces, which aids in digestion. They also play a role in speech and support the structure of the face. In humans, there are four main types of teeth: incisors, canines, premolars, and molars. Each type of tooth has a specific shape and function.

A tooth consists of two main structures:

- Crown: This is the part of your tooth that you can see — theportion above your gums.
- Root: This is the part of your tooth that holds it in your jaw. You can't see the root because your gums cover it. The root anchors your tooth to your periodontal ligament (the soft connective tissue that lines your tooth socket).

Your teeth have four main layers, including:

• **Enamel:**This is the protective outer layer of each tooth. Enamel helps shield your teeth from cavity-causing bacteria. Enamel is the hardest substance in the human body.

• **Dentin:**Just underneath your enamel, there's a layer of dentin. Dentin isn't as strong as enamel. When missing enamel exposes dentin, your risk for cavities increases.

• **Cementum:** covers your tooth root. Along with your periodontal tissues, it helps anchor your tooth firmly in your jaw.

• **Tooth pulp.**This is the innermost layer of your tooth. It contains nerves bloodvessels and connective tissues[1,2,3,4].

1-2- Oral Health Conditions:

Oral health refers to the health of the teeth, gums, and the entire oral-facial system that allows us to smile, speak, and chew. Some of the most common diseases that impact our oral health include cavities (tooth decay), gum (periodontal) disease, and oral cancer.

1-2-1-Cavities:

Cavities are caused by a breakdown of the tooth enamel by acids produced by bacteria located in plaque that collects on teeth, especially along the gumline and in the crevices on the chewing surfaces of the teeth. Eating and drinking foods high in carbohydrates cause this bacterium to produce the acids that can cause the outer coating of the tooth (enamel) or root surface to break down (demineralize). Although cavities are largely preventable, they are one of the most common chronic diseases throughout the lifespan. Untreated tooth decay can lead to abscess (a severe infection) under the gums which can spread to other parts of the body and have serious, and in rare cases fatal, results.

1-2-2-Gum disease:

Gum disease is mainly the result of infections and inflammation of the gums and bone that surround and support the teeth. Certain chronic conditions increase one’s risk for periodontal disease including diabetes, a weakened immune system, poor oral hygiene, and heredity. Tobacco use is also an important risk factor for gum disease. If early forms of periodontal diseases are not treated, the bone that supports the teeth can be lost, and the gums can become infected. Teeth with little bone support can become loose and may eventually have to be extracted.

1-2-3- Oral cancer:

Oral cancer also called mouth cancer, forms in the oral cavity, which includes all parts of your mouth that you can see if you open wide and look in the mirror. Your lips, gums, tongue, cheeks, roof or floor of the mouth.

Preventing high riskbehaviors, that include cigarette, cigar or pipe smoking, use of smokeless tobacco, and excessive use of alcohol are critical in preventing oral cancers. Early detection is key to increasing the survival rate for these cancers[5,6,7,8,9,10,11].

1-3- LASER:

The word laser is an acronym standing for "Light Amplification by Stimulated Emission of Radiation." A laser beam is created from a substance known as an active medium, which when stimulated by light or electricity produces photons of aspecific wavelength[17].Laser effects on tissue may be: Photothermal, Photo ablative, Photomechanical or Photochemical therapy[18].

Laser light is monochromatic and consists of a single wavelength of light. The dental laser delivers light from the machine to the target tissues (soft or hard tissue) in the oral cavity. The laser light increases the temperature of tissues, enabling the removal or modification of target tissues. The temperature can be modulated to achieve the desired effect. Besides cutting and shaping tissues, lasers have several other applications:

- The laser aids in killing disease-causing bacteria. So, lasers are used to disinfect root canals, diseased gums (periodontal pockets), and sites with inflammation around dental implants (peri-implantitis).
- Lasers are used to detect decay in teeth. This is achieved by studying the differences in light-emitting properties of decayed and healthy teeth.
- At low intensities, the laser stimulates the proliferation of certain cells (e.g., fibroblasts) that enhance wound healing.
- In the teeth whitening process, the laser light helps stimulate the teeth whitening solution, accelerating the process.

1-4- Risks involved with the use of lasers in dentistry:

Although the use of lasers is considered safe in dentistry, certain risks are involved if enough precautions are not taken. Below are some of the risks involved:

- Risk to eyes: Most of the lasers can injure or damage eyes. The direct interaction of laser light with naked eyes causes burns in the structures of the eyes. This results in scarring and distortion of vision.
- Risk to skin: In rare cases, due to a high concentration of optical power, lasers can cause skin burns.
- Risk of damage to other tooth structures: Improper irradiation of laser on teeth and diseased gums can damage the dental pulp (innermost layer of the tooth) and underlying tooth-supporting bone[12,13,14,15,16].

1-5- History:

- 1960-first laser
- 1993 Nd: YAG Laser
- 1993 Kinetic Cavity Preparation
- 1994 CO2 Laser, Argon Laser
- 1996 Laser welder
- 1997 Nd : YAP Laser
- 1998 Er: YAG Lase [19].

Review

2-1-Properties of laser:

- **Monochromatic:** all have the same wavelength (color).
- **Collimation (directional):** all waves are parallel with a very small divergence.
- **Coherency:** means that the waves are in the same phase [20].

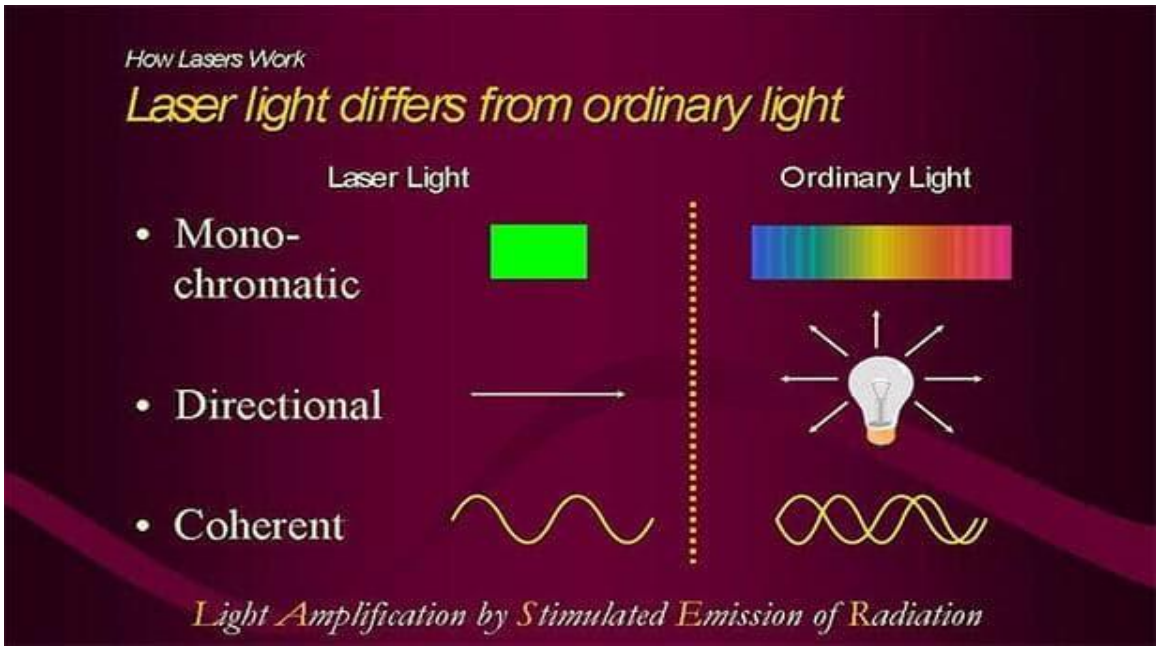

Fig (2-1): laser light differs from ordinary light.

2-2- Laser interaction with tissue:

1- Reflection.2- Scatter.

3- Absorption.4- Transmission [21].

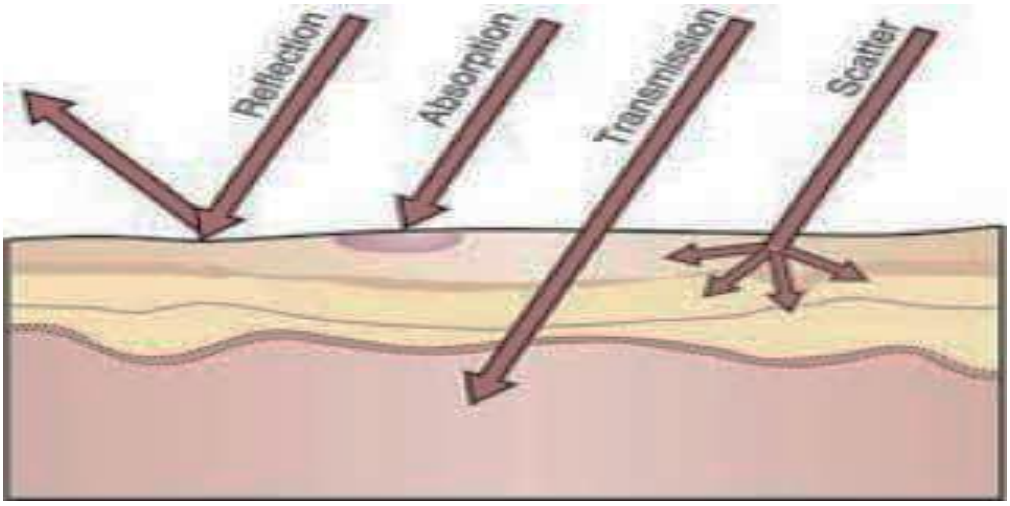

Fig (2-2): laser interaction with tissue.

2-3- Classification of laser:

- Based on wavelength
  - Soft lasers (diode laser).
  - Hard lasers.
- Based on the type of active medium usedsolid, semi-conductor lasers [22].

The most common dental laser used today are Erbium, Nd:YAG, Diode, and CO_2 laser. Each type of laser has specific biological effects and procedures associated with them. A solid understanding of each of these categories of devices is imperative for any clinician hoping to pursue laser use in their practice [23].

2-3-1- Erbium laser:

These are hard-tissue lasers that are attracted to water and hydroxyapatite. It is the laser of choice for treatment of dental hard tissues bone recontouring, preparing teeth for fillings or crowns, hard-tissue crown lengthening, and exposure of teeth under bone and can also be used for soft tissue ablation. One example of this type of laser is the Waterlase laser.

Waterlase laser (the active medium Erbium, Chromium: Yttrium Scandium Gallium Garnet (Er,Cr:YSGG), 2780 nm used for tooth cavity preparation, gingivectomy, frenectomy, biopsy, and treatment of peri-implantitis with minimum amount and in some cases without anesthesia. In addition, it has a bio stimulation effect which promote wound healing and hemostasis [24].

Fig (2-3): Erbium laser.

2-3-2-Diode lasers:

The most economic dental lasers are diode lasers. These are soft-tissue lasers, absorbed primarily by tissue pigment (melanin) and hemoglobin. Because diode lasers are economical and easy to use, they are the ones used most commonly by dental hygienists. Diode lasers are portable, easily moved from operatory to operatory, and deliver very competent results. A few of the diode lasers that are used in hygiene and dental procedures are Gallium-Arsenide laser and Bio laser [24,25].

Gallium-Arsenide laser has a bio stimulation effect by stimulating cell growth of the epithelium, connective tissue, bone and stimulate regeneration of nerve cells.Bio laser active medium is semi-conductor diode utilized for TMJ pain relief and teeth whitening[23,24,25].

Fig (2-4): Diode laser.

2-3-3- Nd:YAGlasers:

They were one of the first lasers clinicians used until diodes became available. Nd:YAG lasers are primarily soft-tissue lasers that can be used for many of the same procedures as diode lasers. They are a little pricier than diodes and a bit bigger in size, but both hygiene and dental professionals still use these lasers today. wavelength is highly absorbed by the pigmented tissue, making it a very effective surgical laser for cutting and coagulating soft tissues[26.

Fig (2-5): Nd:YAG laser.

2-3-4- CO_2 lasers:

They are highly absorbed in tissue due to the interaction of water, and they're superior at cutting soft tissue without bleeding. Two very popular CO_2 lasers are DEKA and DENTA RF (GPT Dental), which continue to impress hygienists and their patients with optimal results. Newer lasers provide even more options for dental hygienists and greatly improve the patient experience.

Another CO_2 laser is the Solea laser. Although CO_2 lasers are primarily used for soft-tissue procedures, Solea is unique in that it is the first CO_2 laser system cleared by the FDA for both hard- and soft-tissue procedures in dentistry. This laser also offers numerous advantages to the dental practice [27].

Fig (2-6): CO_2laser.

Table (2-1): Dental lasers (Types, wavelength & uses)

Review

Type and mode	Wavelength and color	Uses
Excimer (pulsed)	190-351nm UV	Tooth surface conditioning & dentine hypersensitivity.
Argon (continuous)	488 nm blue - 515 nm green	Vascular lesions (port-wine naevus), composite curing.
KTP (potassium-titanyl phosphate), (pulsed)	532 nm green	Telagiectasia, tonsillectomy, salivary duct stricture, tattoo removal.
Tunable dye laser (cont. or pulsed)	504 nm green - 632 nm red	Vascular lesion, tattoo removal, dentine hypersensitivity
Helium-neon (cont.)	633 nm red	Guiding beams and pointers, caries diagnosis, stimulation of wound healing.
Diode laser (pulsed or cont.)	650 nm - 950 nm IR	stimulate the healing process and reduce postoperative complications, treatment of aphthous and herpetic stomatitis, and teeth whitening.
Dual diode (pulsed or cont.)	810 nm and 980 nm IR	gingivectomy, excision of hypertrophic tissue, frenectomy.
Nd: YAG(cont., pulsed or Q- switched)	1060 nm IR	gingivectomy, peri-implantitis, excision of hypertrophic tissue.
Er: YAG (pulsed)	2940 nm IR	Skin resurfacing, caries removal, cutting of enamel, dentine & bone.
Carbon dioxide (cont., pulsed or Q-switched)	10600 nm IR	Tumor removal, coagulation of small vessels, gingivectomy, implant exposure, denture induced hyperplasia, scaling, cutting of enamel, dentine & bone.

2-4- Laser Biopsy:

All dental laser wavelengths can perform precise biopsies safely.Smaller lesions can often be removed with a compounded topical anesthetic only. Sutures are rarely needed due to theexcellent hemostasis and minimal trauma observed when lasers are used properly. Any lesion removed needs to be submitted to an oral pathologist for microscopic diagnosis. [28].

Fig (2-7): Oral Diagnosis - Fibroma removal.

Er:YAG laser excisional biopsy of a fibroma on the buccal mucosa. A compounded topical anesthetic was used. No sutures were placed and the patient had a comfortable postoperative

course. The picture on the right is at six months follow-up exhibits healing with no scarring.

2-5- Laser gingivectomy:

is a dental procedure that recontours or scalpels the gingival tissue to improve long term dental health or aesthetics. Compared to conventional scalpel surgery, soft-tissue dental lasers, such as laser diode, Nd:YAG laser, Er:YAG laser and CO_2 lasers can perform this procedure, offering a precise, stable, bloodless, often less painful, and accelerated healing experience. However, the laser diode gained more popularity due to its versatility, less interaction with hard tissue, ease of use, and the less expensive set up.

Fig (2-8): Oral Diagnosis - gingival tissue.

Figure (2-8) shows Gingivectomy and ClassV Restoration - An elderly patient lost a ClassV restorationEr:YAG .gingivectomy

allowed for precise control of the gingival margin and placement of a restoration. Gingiva growing over implant healing cap excised with Er:YAG laser at abutment placement appointment. No anesthesia was required. Erbium lasers do not interact with titanium and can be safely used around titanium implants.

2-6- Laser Restorative dentistry:

- **Cavity Preparation:**

Recently, the use of laser technology has been introduced as an alternative to traditional mechanical rotating instruments for cavity preparation.Bonding of composite resin to Er :YAG and Er.Cr. : YSGG irradiated enamel and dentin surfaces, more than bonding composite resin to diamond-bur prepared surfaces.

Dental lasers in cavity preparation free from noise, vibration and no need for local anesthesia would therefore, seem to have an assured future.

- Er,Cr:YSGG laser system used in conjugation with air- water spray is effective for preparation of Class I, III and V cavities more conservative cavity preparation because the laser can remove the caries without removal sound enamel below the lesion.

- The composite resin restorations have more retention and less microleakage.

2-7- Caries Detection:

The argon laser energy will offer diagnostic capabilities when used to illuminate teeth.When illuminated with argon laser light, carious tissue has a clinical appearance of a dark, fiery, orange-red color and is easily differentiated from sound tooth structure.Decalcified areas appear as a dull, opaque, orange color.

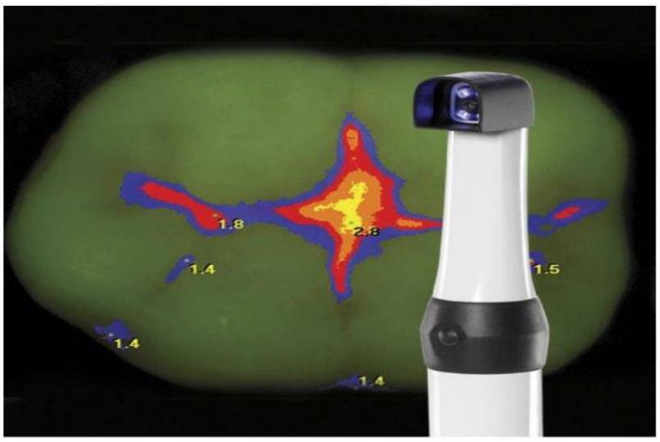

Fig (2-8): Decalcified areas.

2-8- The Advantages of laser:

- May cause less pain in some instances, so reduces the need for anesthesia.

- May reduce anxiety in patients uncomfortable with the use of the dental drill.
- Minimize bleeding and swelling during soft tissue treatments.
- May preserve healthier tooth during cavity removal.

The disadvantages of lasers:

- ❖ Lasers can't be used on teeth with fillings already in place.
- ❖ Lasers can't be used in many commonly performed dental procedures. For example, lasers can't be used to fill cavities located between teeth, around old fillings, and large cavities that need to be prepared for a crown. In addition, lasers cannot be used to remove defective crowns or silver fillings, or prepare teeth for bridges.
- ❖ Traditional drills may still be needed to shape the filling, adjust the bite, and polish the filling even when a laser is used.
- ❖ Lasers do not eliminate the need for anesthesia.
- ❖ Laser treatment tends to be more expensive [29].

2-9- Precautions when used dental laser:

1) Wear appropriate personal protective equipment: The operator and patient should wear protective eyewear during the procedure to prevent eye damage from laser light.
2) Follow manufacturer guidelines: Always follow the manufacturer's guidelines for laser setup and operation, as well as any instructions for maintenance and calibration.
3) Check laser settings: Before each use, verify that the laser settings are appropriate for the intended application and that the laser is functioning properly.
4) Avoid contact with tissues other than the target tissue: The laser should be used only on the target tissue and not on any other tissues, such as the tongue or lips, to avoid injury.
5) Monitor temperature: The laser can generate heat during use, which can damage surrounding tissues. Monitor the temperature and color of the tissue being treated and take breaks if necessary to prevent tissue damage.

6) Use proper technique: Proper technique is important to ensure accurate and precise treatment with minimal thermal damage to surrounding tissues. Seek appropriate training before using the laser for any clinical applications.
7) Provide appropriate post-operative care: Patients may experience discomfort or swelling after laser treatment. Provide appropriate post-operative care, such as pain medication or ice packs, as needed.
8) Keep laser out of reach of children: When not in use, the laser should be stored in a safe place, out of reach of children.

Conclusion

Laser dentistry potentially offers a more comfortable treatment option for a number of dental procedures involving hard or soft tissue compared to drills and other non-laser tools.

Treatment by laser offer more advantages than conventional such as less bleeding less anaesthesia and less scarring tissues.

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