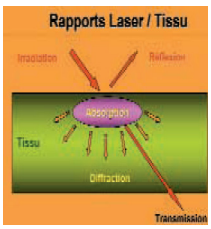
DOI: 10.1051/odfen/2009404

J Dentofacial Anom Orthod 2009;12:139-144

How to make an informed choice of the right laser



Jacques BERREBI

ABSTRACT

There has been a considerable increase in the clinical use of lasers in dentistry over the past thirty years, especially in orthodontics. But clinicians who have not yet made their decisions about participating in this technological revolution can be perplexed by the great variety of wave lengths available, the vast number of machines that can be used to employ them, and the complexity of the principles of physics upon which lasers beams are based.

The objective of this article is to give practitioners a better understanding of the indications for the use of the various types of lasers.

KEYWORDS

Laser

Absorption

Wave length

Laser-tissue relationship

Orthodontics.

Address for correspondence:
J. BERREBI,
20, rue Val de Bouille,
72240 Conlie.
jacques.berrebi@neuf.fr

1 - INTRODUCTION

While other medical specialists have been using lasers for some considerable time, dentists have begun to employ only relative recently (fig. 1).

The word L.A.S.E.R. is an acronym of ''Light Amplification by Stimulated Emission of Radiation''.

The goal of this article is to review the theoretical basis for the action of the different types of lasers so that practitioners, especially orthodontists, will be able to differentiate between the indications for each.

Figure 1
Clinical use of a CO_2 laser.
(J. Berrebi).

2 - THEORETICAL REVIEW

A laser is made up of three components (fig. 2):

– a gain active medium (a gas, a solid or a coloring agent, from which the name of the laser is derived, for example CO2 laser, Erbium laser, or Diode laser;

– a means of initiating action, an electrical discharge, for example, that raises the electrons in the milieu to a higher energy level. This stimulation of the gain medium is called ''pumping.''

– a resonant optic cavity made up of two mirrors located at opposite ends of the laser, one of which is a semi-reflector. After pumping of the electrons, a photon is injected into the gain medium to stimulate photon emission. The two mirrors allow the stimulated photons to bounce back and forth until they leave through the semi- reflecting mirror.

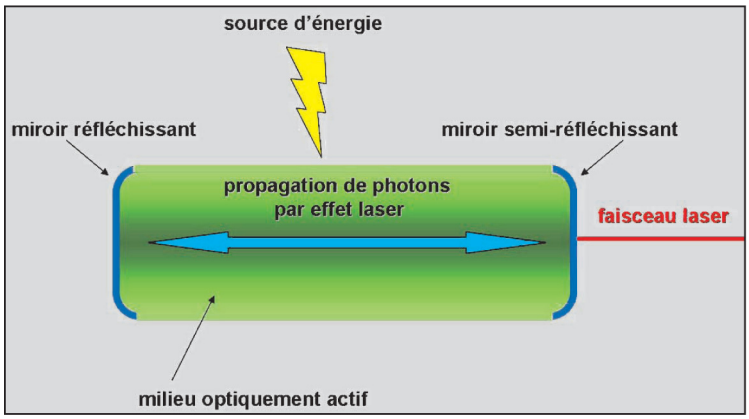


Figure 2
Explanatory schema of the way a laser functions.

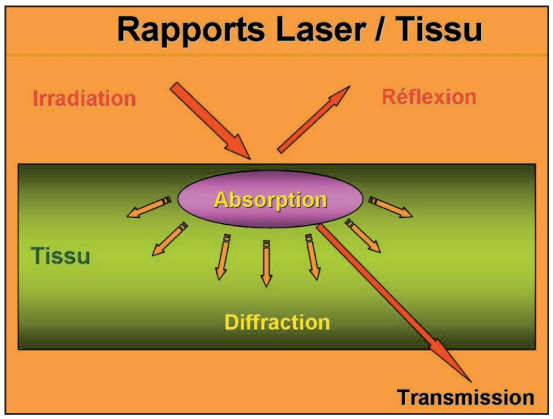


Figure 3
Laser/tissue relationships.

– the resultant luminous energy is transmitted to the assigned tissues either through the intermediary of laser optic fibers or by an articulated arm.

The laser beam is monochromatic and diverges only slightly. Its spatial coherence assures that it travels in a single direction and its temporal coherence keeps all the photons in phase. Medically, these characteristics make lasers a powerful and precise tool.

The applications of lasers in dentistry depend upon the special quality of their action on targeted tissues. Among the four possible effects on tissues of reflection, absorption, diffraction and transmission (fig. 3), the principal clinical applications depend on the extent to which they are absorbed, while, at the same time, their diffraction is limited as much as possible.

3 - CRITERIA FOR THE CHOICE OF LASERS IN ENTISTRY

Here is an analysis of the indications for different lasers in dentistry with respect to these aspects:

3 - 1 - The Laser/Tissue relationship

In order for the spread of the laser beam on selected tissue to be effective, its absorption by that tissue must be optimal. So dentists should choose a laser whose coefficients of absorption best fit the tissues it will be targeting (fig. 4). When absorption by the treated tissues is insufficient, underlying tissues or structures may be subjected to excessive heat (fig. 3).

3 - 2 - Mechanisms of the action of lasers

Within the oral cavity practitioners can effectively utilize the photothermic effect of these lasers, the CO_2:

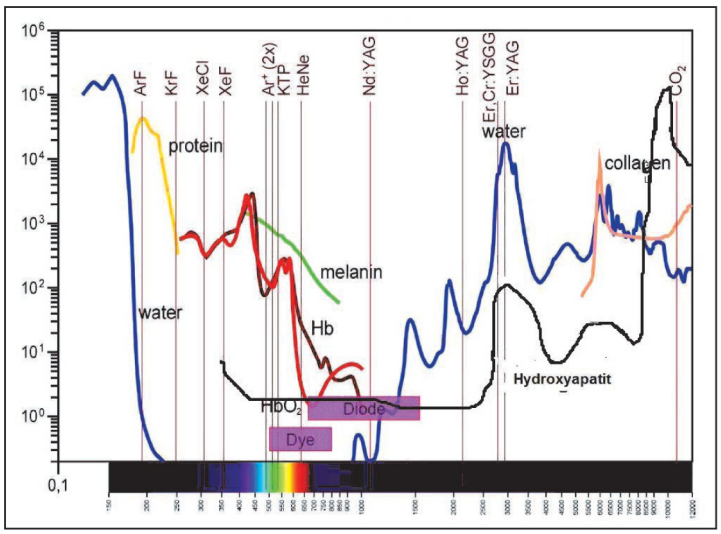


Figure 4
Absorption values for the principal wave lengths in different biologic tissues.

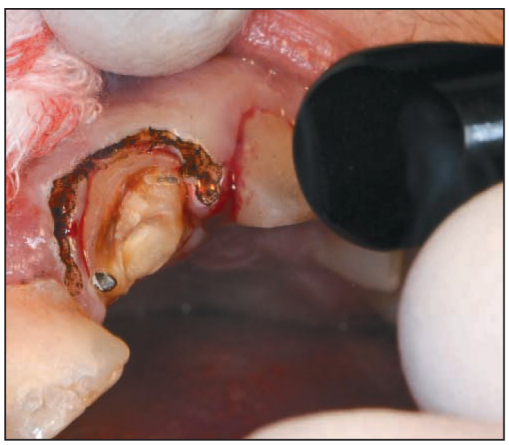


Figure 5
With a CO2 laser, a dentist can re-contour gingiva with precision and without risk of postoperative recession. The practitioner should not be alarmed if some of the treated tissue appears charred after the procedure. The gingiva will recover its normal coloration within 48 to 72 hours. In the case depicted in this illustration, the practitioner was able to restore correct gingival contours around a fractured post with a CO_2 laser.
(J. Berrebi-from Professor. Sixou's team).

10600 nanometers, the Nd: YAG: 1064 nm, the Diodes: 810 nm and 980 nm, and the KTP: 532 nm, whose mechanism of action controls and limits elevation of temperature to the targeted area where it causes fusion or vaporization of the tissue, whichever is required (fig. 5).

Other lasers, the Er-Yag: 2940 nm and the Er Cr-Yag: 2780 nm, create a photo-mechanical effect. Their mechanism of action, which creates no heat, consists of micro-explosions that remove the selected tissues.

The final category of lasers, the KTP: 532 nm - Argon: 514 nm and the 488 nm - Photo Dynamic, which are photochemical, use a diode beam that transforms the chemical nature of the targeted tissue.

3 - 3 - A review of the technical conception of lasers

Depending on the technology of the way they work, lasers can be separated into two categories the fiber lasers and the mirror lasers.

The fiber lasers, the Nd: YAG, the Nd: YAP, the Diodes and some others, because of their nature, are easiest to manipulate. Dentists can place their fibrous extremities in areas difficult to access such as periodontal pockets and root canals but they are also more fragile, losing a considerable amount of power between the source of the beam and the extremity of the fiber.

The mirror lasers[2] (CO_2 - Er-Yag...), are not as fragile and they suffer much less power loss between the source of the beam and the hand held tool dentists use in the mouth. But they can be employed only in readily accessible sites.

By carefully assessing the three sets of Information we have just outlined, clinicians should be able to gain a better understanding of how lasers act upon a selected tissue area and thereby make an informed choice on which type to select for the therapeutic results they wish to achieve.

4 - MAKING AN INFORMED CHOICE FROM A SHORT LIST OF LASERS

A review of the different characteristics of lasers available in dentistry today suggests that none of them has a sufficiently wide-ranging wave length to make it capable of serving all the applications required in dental practice: even the Erbium group of lasers, whose gamut of application currently appears to be the most extended, are essentially acceptable only for use on hard tissues; when they are directed at mucogingival tissues they are effective and relatively risk free but they cause so much bleeding that they are not suitable for surgical intervention during the course of orthodontic treatment.

Here are our suggestions for the best choice of a laser to satisfy essential clinical requirements in dentistry, and, especially, in orthodontics (fig. 6):

– **for surgery,** the CO2 is the one to select because it controls bleeding so well, the diodes are also useful in surgery but not as effective because they are not as well absorbed by the moisture in targeted mucosal tissues;

– **for preparation of enamel** or **the removal of ceramic brackets**, the Erbium Yag and the Erbium Chrome Yag;

– **for treating hypersensitive dentin,** the Nd: YAG associated with application of graphite powder on the selected area.

– **for whitening teeth[3]**, the KTP associated with the application of a red colored hydrogen peroxide gel;

– **for placing preventive anti-caries fluoride on tooth surfaces**, the Argon laser.

Lasers	Diode	NdYag	NdYap	ErYag	Er,Cr3 :YSGG	CO2	KTP	Softs lasers
Longueurs d'onde	810 nm 980 nm	1 064 nm	1 340 nm	2 940 nm	2 780 nm	10 600 nm	532 nm	Infrarouge proche→visible (diodes)
Rapport laser/tissus bucco-dentaires *Absorption dans :*								
· *Eau*	1/5	2/5	3/5	5/5	5/5	4/5	/	/
· *Hémoglobine*	3/5	4/5	4/5	1/5	1/5	1/5	4/5	/
· *Hydro xyapatite*	1/5	1/5	1/5	3/5	3/5	/	4/5	/
·*Mélanine (noir)*	3/5	2/5	2/5	/	/	/	4/5	/
Transport du faisceau	Fibre	Fibre	Fibre	Miroir ou fibre	Fibre	Miroir	Fibre	Fibre
Meilleures applications cliniques *(liste non exhaustive)*	• Traitement endocanalaire • Traitement des poches parodontales • Pour les autres applications, il faut rajouter de l'encre de Chine	• Traitement endocanalaire • Traitement des poches parodontales • Aphtes, ulcères, herpès • Désensibilisation des collets avec l'application de poudre de graphite	• Traitement endocanalaire • Traitement des poches parodontales	• Soins des tissus durs (caries) • Traitement endocanalaire • Traitement des poches parodontales • Chirurgie avec saignement • Freinectomie décapuchonnage d'implants...	• Soins des tissus durs (caries) • Traitement endocanalaire • Traitement des poches parodontales • Chirurgie avec saignement	• Traitement parodontal dans les lésions supra osseuses (gingivites) • Chirurgie sans saignements • Décapuchonnage d'implants • Freinectomie • Chirurgie pour l'orthodontie, mise en place d'une canine incluse	• Éclaircissement dentaire • Petite chirurgie	• Biostimulation des lésions inflammatoires • SADAM • Cicatrisation des plaies après extraction

Figure 6
A drawing recapitulating the principal indications for the use of lasers in dentistry.
(L. Bury, J. Berrebi).

5 - CONCLUSION

A review of the essential physical characteristics of lasers can help clinicians understand the principles of the action of laser technology and thus to make an informed choice of the one best suited for each clinical situation.

REFERENCES

1. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in non surgical periodontal therapy. Periodontol 2000, 2004;36:59-97.
2. Berrebi J. Intérêt du laser CO_2 dans les traitements par coiffage pulpaire direct et pulpotomie. Mémoire de Master (EMDOLA), Faculté de Médecine Dentaire, Liège, Belgique ; 2008.
3. Berrebi J. Eclaircissement dentaire au laser. Journal du dentiste 2008;371:12-5.