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Lasers in orthodontics

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Abstract
Dentistry, in all its neoteric era revolves around the techniques and procedures that are advantageous and patient friendly. Such a research led to the institution of light amplification and stimulated emission of radiation technique, both in medicine and dentistry. Lasers are currently being followed in all the specialties including orthodontics, wherein it has dramatically decreased the treatment timings, resulting in better outcomes along with pain reduction procedures, greater patient satisfaction and a superior practice.

Keywords: Light amplification and stimulated emission of radiation (LASER), Orthodontics, Dentistry, LLLT, Accelerated tooth movement, Crown lengthening, Micro-etching of enamel.

Introduction
Lasers are finding their way into today's top orthodontic practices, aiding the doctors in managing usual soft tissue problems associated with patients in braces. Launching this technology safely and successfully depends largely on the doctor's commitment to doing it right. It is important to engage in training and developing systems for incorporating procedures into practice. Integrating these steps, greatly facilitates laser implementation and advances the orthodontist's expertise, confidence, and satisfaction.

History of the Laser: "LASER," an acronym for light amplification for stimulated emission of radiation, is a device for generating high intensity, evidently parallel beam of monochromatic electromagnetic radiation. The probability of stimulated emission was anticipated by Einstein in 1917.

Theodore Maiman[1] created a first operational laser in 1960, based on the work of Gordon in 1955 and Schawlow and Townes in 1958. A ruby laser emitting a brilliant red beam of light was constructed. Development of argon, carbon dioxide, and neodymium: yttrium-aluminium-garnet (Nd:YAG)[2,3] lasers within 3 years from the construction of ruby laser occurred. These remain the most widely used lasers in dentistry and medicine till date. Soft lasers, which are based on the semiconductor diode devices, are compact, low-cost devices being used predominantly, are termed as low-level laser therapy (LLLT) or 'biostimulation'.[4] The probability of stimulated emission was anticipated by Einstein in 1917.[5]

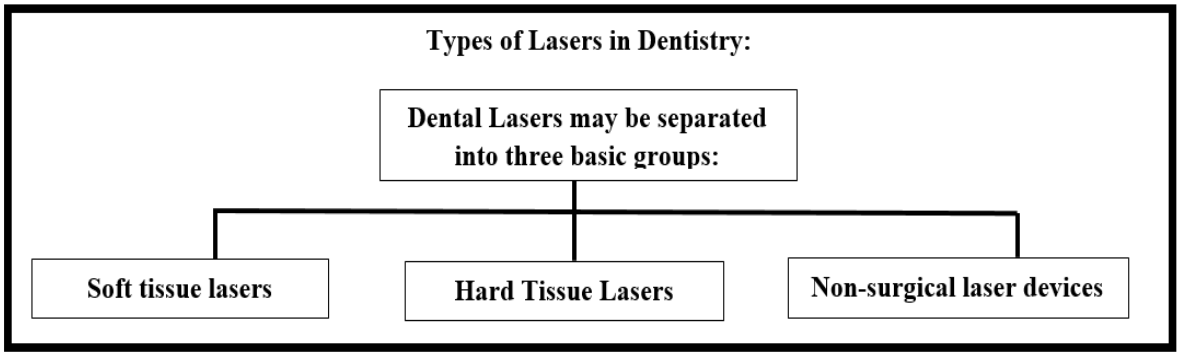

Fig. 1: Flowchart depicting types of lasers used in dentistry

Types of Lasers: There are about four types of lasers being used in dentistry today.
Erbium Laser: This laser can be used on hard tissue[6] for cavity preparation or bone cutting, using short pulses of 50-100 microseconds. It can also be used on soft tissue, using longer pulses of 300-1000 microseconds. In this mode it can be used for periodontal procedures, gingival contouring, frenectomies, facial resurfacing or biopsies. The benefits of using this type of laser include minimal heat penetration,[7] rapid healing and minimal postoperative pain. However, these lasers are large and expensive and have significantly more capability than an orthodontist generally would use in everyday cases.

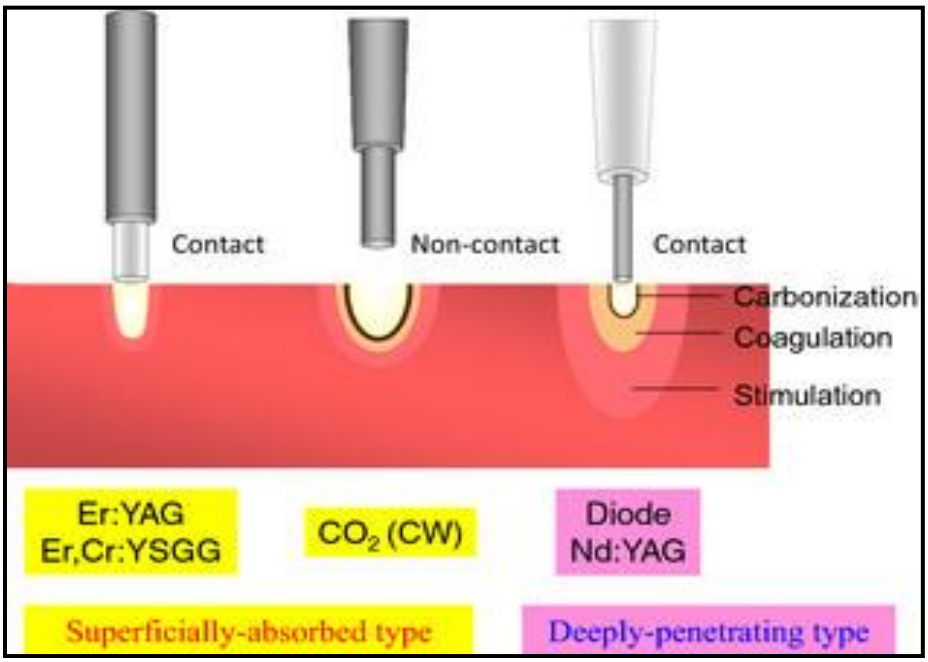

Fig. 2: Tissue penetration of different types of laser
Image source: (http://www.mdpi.com/2076-3417/5/4/1350)

Nd:YAG Laser: This was the first laser designed for dentists, and was introduced in 1990. A pulse laser with a wavelength of 1064nm, the Nd:YAG laser has the unique ability to penetrate deep into the tissue,[8] and can even stimulate fibrin formation, aiding in the coagulation of operative sites. This laser has been used in the periodontal field[9] for disinfection and debridement of periodontal pockets and the Laser Assisted New Attachment Procedure (LANAP).[10]

CO2 Laser: Introduced in the 1970s, this laser has a wavelength of 1060nm and is highly absorbed by[11] water. It is very good at hemostasis but can be used on soft tissue only. It is useful for cutting soft tissue with reduced charring, and is used most frequently for biopsies. Sutures are seldom needed since hemostasis is exceptionally good.

Diode Laser: Compact and affordable, this laser is used most frequently by orthodontists for soft-tissue management. The diode laser's wavelengths range from 805-1064nm, which means it can only be used on soft tissue. A wavelength of 940nm represents peaks for the absorption of laser energy by hemoglobin, oxyhemoglobin and water, making the 940nm diode laser very effective as an instrument to incise gingival tissue.

A diode laser uses heat as the energy source to incise the tissue, and it can be used quite effectively for frenectomies and photostimulation of the apthous and herpetic lesions.[12] It is also utilized in doing biopsies, canine exposure, gingival recontouring and gingivectomies. Minor charring is very common around the surgical site, but resolves within a three- to five-day window under normal circumstances. The light energy produced by a laser can have four different interactions with a target tissue.[13,14] Reflection, transmission, scattering, and absorption.

Table 1: Comparisons of lasers used in dentistry

S. No.	Laser Type	Wavelength	Tissues	Examples
1	Diode	800 – 900 nm	Soft and Hard	1. Soft tissue crown Lengthening 2. Tissue removal from orthodontic brackets 3. Frenectomy 4. Excisional biopsy 5. Tooth whitening 6. Caries detection 7. Desensitization 8. Treat temporomandibular joint disorder
2	Nd: YAG	1064 nm	Hard	1. Tissue retraction

				2. Biopsies
3	Er: YAG	2940 nm	Soft	1. Cavity Preparation 2. Endodontic procedures 3. Calculus removal 4. Sealant preparation
4	Er Cr: YSGG	2780 nm	Hard and Soft	1. Root debridement and scaling 2. Cavity preparation 3. Lesion removal 4. Excisional biopsy 5. Aphthous ulcer treatment
5	CO_2	1060 nm	Soft	1. Frenectomy 2. Biopsy 3. Gingivectomy 4. Gingivoplasty
6	Argon	514 nm	Soft	1. Curing 2. Whitening 3. Coagulation 4. Transillumination

Steps to incorporate laser into practice:

I: Invest in a good dental diode laser system suitable to your needs and budget

The factors to be taken into consideration are:

1. Need
2. Wavelength
3. Pulse characteristics
4. Maximum wattage
5. Budget

II: Laser implementation into practice

1. Ensure Maximum Safety with personal protective equipment (safety glasses for the doctor staff as well as the patient)
2. Adequate training of the doctor and the staff
3. Treatment area modifications
4. Minimize reflective surfaces
5. Ensure manufacturer safeguards are in place
6. Use high volume suction
7. Follow normal infection control protocols
8. Designate a staff member as laser safety in charge.

III: Obtaining patients detailed history and informed consent

IV: Planning

1. Laser mode selection for different procedures
2. Doctor must know their limitations and schedule accordingly
3. Anesthesia levels to be planned according to the patient.

Dental laser wavelength on electromagnetic spectrum

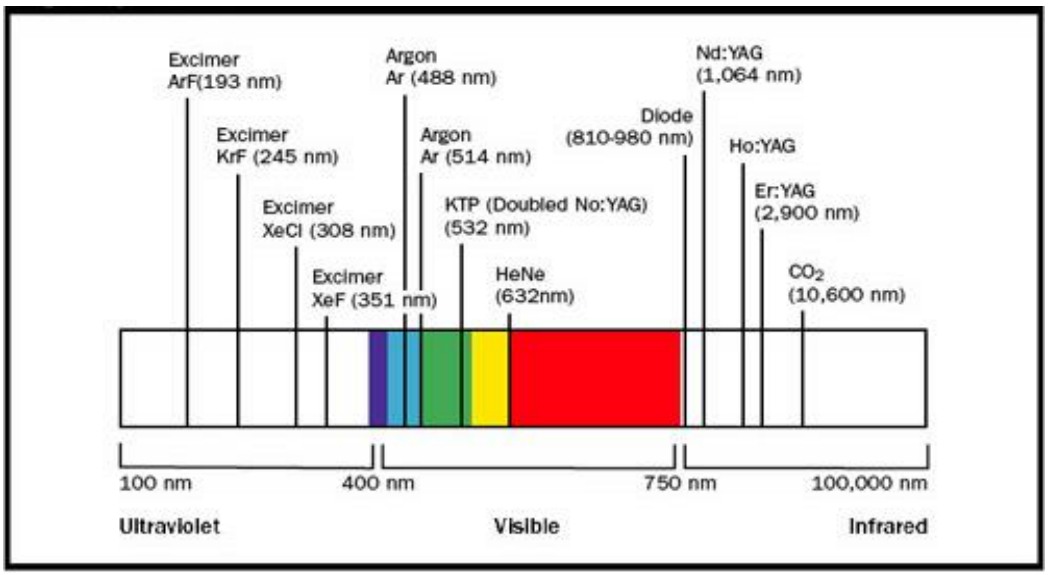

Fig. 3: Tissue penetration of different types of laser

Image source: (https://www.dentalcetoday.com/courses/28/HTML/dt_section_1.htm)

Orthodontic Clinical Applications: Specific procedures include aesthetic gingival recontouring, soft tissue crown lengthening, exposure of impacted teeth, removal of inflamed and hypertrophic tissue, healing of wound[16] and frenectomies. Incorporating the use of lasers into orthodontic practice has been extremely productive on many levels. Placement of brackets more accurately and healing of exposed impacted teeth has significantly reduced treatment time and patients appreciate, the reduction of surgical complications and appreciate the way their smile has improved in a much lesser time.

1. Exposure of un-erupted and partially erupted teeth (reduced bleeding and swelling, improved precision, reduced pain and improved healing).
2. Isolated areas of transient tissue hypertrophy can easily be removed with the diode laser.[17]
3. Gingivectomy, gingivoplasty; gingival recontouring and esthetic crown lengthening.[18,19]
4. Frenectomies; A laser permits painless excision of frenum, without bleeding, sutures, surgical packing, or special postoperative care.[20]
5. Accelerate orthodontic tooth movement
6. Temporomandibular disorders pain management therapy.[21-23]
7. Pain control with Low level laser therapy (LLLT) or 'biostimulation'.[4,24-27]
8. Enamel etching[28,29]
9. Bonding
10. Bracket debonding
11. Homeostasis
12. Newer brackets with bracket base being cut by the laser technology.
13. Wound healing and treatment of traumatic and aphthous ulcers.[16]
14. Treatment of Post herpetic neuralgia.[17, 20, 30-32]
15. Holographic studies.[33- 35]

Conclusion

Laser treatment enhances patient experience and saves considerable time.

The patient experience is very positive and in most cases only a topical anaesthetic is used and generally most patients report that they did not need to take any analgesics following the procedures. Incorporating laser technology could significantly benefit any orthodontic practice as an aid for adjunct procedures.

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