Erbium lasers in pediatric dentistry

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Fig. 1


Fig. 2

Fig. 1_Upper labial frenum with deep papillary insertion at the palatal site, in a 9-year-old child.
Fig. 2_Er:YAG laser labial frenectomy.

_Introduction

Taking care of a pediatric patient's oral health is a challenging task, but one that can be exceptionally rewarding. Providing a positive experience to children enables them to have a trusting, long-term relationship with a dental professional. Combining skill, knowledge and cutting-edge diagnostic and operative technologies help to guide children toward a lifetime of good oral health. Among the many motivational, diagnostic and operative innovations to consider, one must include lasers. Laser technology in pediatric dentistry today is a new treatment modality for children and teens; it represents an alternative instrument that sometimes complements, and at other times substitutes for traditional techniques. Laser treatment of hard and soft tissues allows for a more comfortable and minimally invasive intervention. In addition to the use of high technology, the psychological effect on the child represents an important benefit which may positively influence the acceptance of subsequent dental treatments.

Several of the factors that make laser therapy an elective procedure in pediatric dentistry are:
- Its minimally invasive nature, with more affinity for carious tissue (higher water content);
- Higher safety, because it does not use rotating instruments or blades in a small mouth (which can move unpredictably);
- It is more comfortable for the patient due to the lack of direct contact and vibration on the tissue surface;
- It is more acceptable because in many cases the use of local anaesthetics can be avoided;

Table 1

Operative Advantages:

Comfort:	non-contact—no vibration/noise
Safety:	no rotating or cutting instruments used in the mouth
Painless:	reduced need for local anaesthesia or no anaesthesia
Approach:	improved patient compliance

Clinical Advantages:

Minimally invasive:
selective for carious tissue
Decontaminating effect for deep caries
Micro-retentive surface:
a cleaned and debrided surface
Less rise in temperature in pulp and periodontal surface during irradiation
Direct pulp capping:
coagulation/bactericidal effect
Soft-tissue application:
exposure of subgingival tooth margins during cavity preparation

Table 2

Operative Advantages:

Comfort:	non-contact mode
Safety:	no cutting instruments used in the mouth
Painless:	reduced need for local anaesthesia or no anaesthesia
Approach:	improved patient compliance
Easy use:	intuitive, knowledge of the science more important than skill

Clinical Advantages:

Minimally invasive:
selective for fibrous and/or inflamed tissues
Decontaminating effect of the surgical site
Coagulating effect of near-infrared lasers
No rise in temperature in tissue for medium-infrared lasers
Soft-tissue healing:
comfortable post-operative period

Table 1_Operative and clinical advantages of lasers in restorative treatments.
Table 2_Operative and clinical advantages of lasers in soft-tissue treatments.

- It allows for easier and faster minor gingival and mucogingival surgery without scalpel or suture, and with good control of bleeding;
- Secondary intention healing and the postsurgical period are predictable and usually asymptomatic;
- The use of an innovative technology such as the laser is also well accepted by parents, who appreciate being able to offer their children the advantages of laser care. It also provides a favourable psychological impact on the child, who with his or her imagination, may see the laser as a magical tool that uses "light and water to clean teeth".

All these advantages allow laser therapy to improve patient compliance by positively influencing both the objective factors that affect the perception of pain (see the operative advantages of laser technology in Tables 1 & 2) and the subjective factors of pain, by raising the threshold of pain (analgesic effect) and the threshold of suffering (reducing the incidence of the anxiety or fear related to a negative personal or family experience when "needles, drills, scalpels, sutures, etc." are used, thus influencing the cognitive and emotional state of the patient).[1]

For these reasons the use of the laser with pediatric patients has proved to be a valid method of intervention, as noted by a number of authors who have reported good levels of patient acceptance during hard and soft tissue therapy. [1,3,4,5,6,7,8,9,10,11,12,13]

_Clinical laser applications

Various applications are possible on both hard and soft tissues using different laser wavelengths. Each wavelength has its own applications due to the spe-


Fig. 3


Fig. 4

Fig. 3_Typical secondary intention healing after one week.
Fig. 4_Complete and stable healing of the labial frenum, with new attachment on the mucogingival junction, after one year.

Table 3_Common applications of lasers in pediatric dentistry.

Table 3

Hard-Tissue Laser Applications
Preventive Dentistry: laser-assisted fissure sealing, MIH
Restorative Dentistry: carious removal and cavity preparation
Endodontics: laser-assisted pulp capping, pulpotomy and pulpectomy;
root canal debriding and decontamination

Soft-Tissue Laser Applications
Oral Pathology: gingival hyperplasia, fibrous hyperplasia, fibroma, epulis, mucocele, eruption cyst, dentigerous cyst, foreign bodies
Orthodontics: exposure of impacted teeth, distal molar operculectomy,
gingival contouring, intraoral attachment welding, ceramic bracket debonding
Periodontics: gingival contouring, labial frenotomy/frenectomy, lingual frenum release

Laser Applications for Dental Trauma
Trauma to hard tissue and pulp
Trauma to periodontal tissue

Low Level Laser Therapy
TMJ pain, orthodontic pain;
Muscular trismus and contracture;
For accelerating orthodontic movements;
Herpes, aphthous or orthodontic ulcers;
Dental trauma

cific type of biological absorption of each tissue that is targeted: visible, near, medium and far infrared lasers interact differently with different chromophores (melanin, haemoglobin, water and hydroxyapatite) contained in different target tissues (mucosa, gingiva, dental tissues) and therefore the laser choice is regulated by the optical affinity and coefficient of absorption of the tissues for each particular wavelength.

Lasers in the visible and near-infrared electromagnetic spectrum are specifically absorbed by haemoglobin and melanin and are used in the treatment of soft-tissues pathologies. On the other side, the Erbium lasers, in the medium infrared spectrum, are absorbed by water in gum and mucosa and by water surrounding the hydroxyapatite, and are therefore used on both soft and hard tissues. Among all the wavelengths used in dentistry, the Er:YAG laser (2,940 nm) is the most highly absorbed in water and has proven to be the most flexible, all-purpose laser in dentistry. In the far-infrared spectrum, the CO_2 lasers (9,300 and 10,600 nm) are also primarily absorbed by water in gum and mucosa and are used in oral surgery for the incision and vaporization of soft tissues. It is important to underline that with healthy gum and mucosa, the water chromophore is prevalent—while haemoglobin (blood) is prevalent in inflamed and in vascular tissue.

If a dentist has multiple lasers, the wavelength choice must be taken according to the type of healthy or pathologic tissue: mucosa, keratinized and non-keratinized gingival, fibrous tissue. Additional differences are dependent on location, health condition, pigmentation, vascularization, hydration and can be summarized as biotype variances.[14,15] All wavelengths absorbed by either water or haemoglobin are also used for the coagulation, vaporization or removal of the pulp tissue (vital and non-vital pulp therapy). For the application of laser energy in pediatric dentistry, the Erbium:YAG laser is considered as the most usable, all-tissue laser.

_Laser analgesia: an advantage in pediatric dentistry

Among the several advantages of lasers in dental applications, laser-induced analgesia represents a unique way to treat an infantile patient with minimal or no discomfort. Laser irradiation of the operatory site with low energy prior to any surgical or non-surgical procedure generates disruption of the NA+/K+ pump of the cell membrane of the nervous fibers, causing a temporary loss of conductance of the nervous impulse and a consequent analgesic effect in the irradiated area. Naturally, operating below the threshold of pain (by using the minimum effective energy and power) helps to avoid betraying the child's trust.[14]

_Hard and soft tissue laser

The high affinity for water, the main chromophore in carious and soft tissues, makes this laser the safest and easily used in many procedures on healthy, demineralised and carious dental tissues (enamel and dentin) as well on gingival and mucogingival tissues.

When approaching the panel setting, it is important to consider the different water content of the dif-

Fig. 5_Proximal caries in lower primary molars in a 6-year-old patient. LightWalker Er:YAG laser, treating both carious tissue and marginal gingiva for healthy tissue exposure.
Fig. 6_Cavity preparation and gingivectomy performed: note absence of bleeding and thermal damage to the soft tissue.
Fig. 7_Restoration completed.


Fig. 5


Fig. 6


Fig. 7


Fig. 8

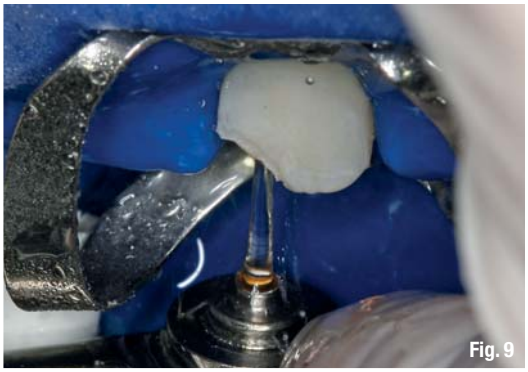
Fig. 9


Fig. 10a

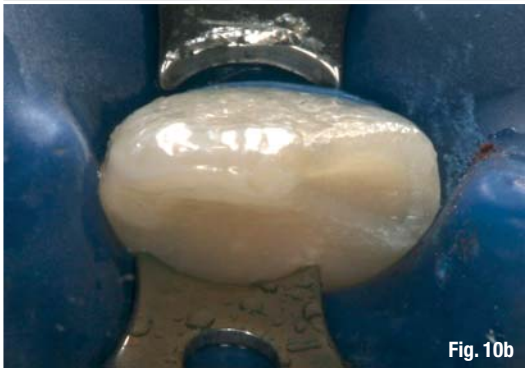
Fig. 10b

Fig. 8_Uncomplicated enamel-dentin fracture in a 10-year-old patient.
Fig. 9_LightWalker Er:YAG laser is used for cleaning, decontamination and roughening of dental structure.
Fig. 10a & b_Fractured upper central incisor cleaned and prepared with erbium laser: before (a) and after (b).

ferent tissues, such as enamel and dentin, and the different composition of the primary tooth compared to the permanent tooth (newly erupted versus aged) and adjust the parameters accordingly.[16,19] As previously reported, the pulp tissue is high in water content and is readily vaporized with the Erbium:YAG laser, and therefore care must be taken with deep cavities that are very close to pulp chamber (Figs. 8–10).[20,21] Vaporization and coagulation of the pulp is very well performed by the latest technology of the Er:YAG laser, with a very low rise in temperature in the remaining tissue, which is important for the pulp vitality during pulp coagulation or pulpotomy. The LightWalker (2,940 nm; Fotona, Ljubljana, Slovenia) at 5 or 10 mJ, 15 Hz, at 300 microseconds pulse duration, 5 to 10 seconds defocused exposure, is very effective for pulp coagulation during a pulp-capping procedure. Soft-tissue procedures are easily performed and the Erbium:YAG laser never produces tissue carbonisation even at high energy (Figs. 1–7).

The use of water spray and the possibility to modulate the duration of the pulse allows for greater or lesser thermal interaction for different procedures (the interaction is more thermal with a low ratio of water spray and less thermal when a higher water spray ratio is used). A gingivectomy or a frenectomy will be performed with a longer pulse duration (300–600 microseconds) than a cavity preparation (50–100 micros) and with different energy. When treating multiple tissues in the same intervention, for example bone and gingiva/mucosa in a labial frenectomy or impacted tooth exposure, care must be taken in varying the settings according to the different tissues.

_Conclusion

Lasers have demonstrated their effectiveness and safety for pediatric dental care. The Erbium:YAG laser, in particular, allows the clinician to perform an innovative, minimally invasive form of dentistry that is very well accepted by children.

Before starting to use a laser, it is important to understand the physical characteristics of the different laser wavelengths and their interaction with biological tissues to assure that they are used in a safe way, in order to provide the benefits of this technology to young patients. It is therefore highly recommended to invest in the appropriate training and education before applying this technology on pediatric patients._

_contact laser

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