Paediatric laser dentistry. Part 4: Soft tissue laser applications

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ABSTRACT

Lasers can provide effective soft tissues applications in children. All the wavelengths produce incision and vaporisation of oral tissues, together with a high bactericidal effect. The haemosthatic effect varys according to the wavelength used, and the choice of a visibile, near, medium or far infrared laser allows a better interaction with specific targets, gingiva, mucosa, frenum, or oral pathology.

Keywords *Laser frenectomy; Laser gingivectomy; Lingual frenum release; paediatric oral tissues care.*

Laser effects on soft tissues

Lasers are used in paediatric dentistry for soft tissue applications in Oral Pathology, Periodontics and Orthodontics [Olivi et al., 2009; Olivi et al., 2011a]. Advantages of laser surgical technique compared to conventional procedures are listed in Table 1. Accordingly, laser therapy can improve the quality of the results, maintaining or improving the patient's acceptance and compliance [Parkins, 2000; Boj et al., 2005; Haytac and Ozcelik, 2006; Genovese and Olivi, 2008; Kara, 2008; Akpinar et al., 2015].

The benefits resulting from the use of laser comes from an in-depth knowledge of the principles of the laser-tissue interaction. This interaction is primarily determined by the wavelength's affinity for specific chromophore of different tissues [Pang et al., 2010].

The laser wavelengths with optical affinity for haemoglobin and water (the main chromophores contained in gingiva and mucosa) can be used for soft tissue applications. Visible and near and infrared lasers are highly absorbed by haemoglobin and melanin, offering excellent coagulation and bleeding control during incision and vaporisation [Paglia et al., 2015]. Medium and far infrared lasers are highly absorbed in water, providing efficient incision and vaporisation of less vascularised, keratinised and fibrous tissues [Olivi et al., 2011b].

Oral soft tissues contain a variety of healthy and pathologic tissue types: mucosa, keratinised gingiva and non-keratinized gingiva, fibrous lingual and labial frenula. This must be taken into account when choosing the correct laser wavelenght and settings. Additional differences depend on location, health status, pigmentation, vascularisation, hydration and can be defined as biotype variances [Pang et al., 2010]. The best results occur when the appropriate wavelength is matched to the main chromophore within the target tissue, maximising absorption. Inflamed tissues, which contain more blood and therefore more pigment and haemoglobin, will react favourably to wavelengths in the visible and near-infrared spectrum of light. Also a vascular pathology, such as haemangioma or a pyogenic granuloma will be better treated with a visible or near infrared laser [Angiero et al., 2008], but a fibrous epulis [Olivi et al., 2007] or a frenum [Olivi et al., 2012] will respond better to a medium or far-infrared laser because of the high absorption in water [Genovese and Olivi, 2010].

Effects on soft tissues

The laser energy absorbed and/or diffused into the tissues is transformed, causing different effects on the targeted tissues. The photothermal effect represents the main effect of laser radiation on soft tissues (effect common to all wavelengths). The thermal effect produces several

Operative Advantages	
Safety	No scalpel or cutting instruments used in the mouth
Precision	Excellent operative view due to the bleeding control
Ease	Simple and rapid to use
Painless	Less use of local anaesthesia or no anaesthesia are required
Approach	Improvement of patients' compliance
Clinical Advantages	
Decontaminating effect	Reduced incidence of postoperative swelling
Hemostatic effect	Excellent coagulation effect during and after surgery
Fast	Possibility of not applying sutures
Post-operative recovery	Often asymptomatic with less need for analgesics and anti-inflammatory medications.

TABLE 1 Advantages of laser on soft tissue compared to conventional procedures.

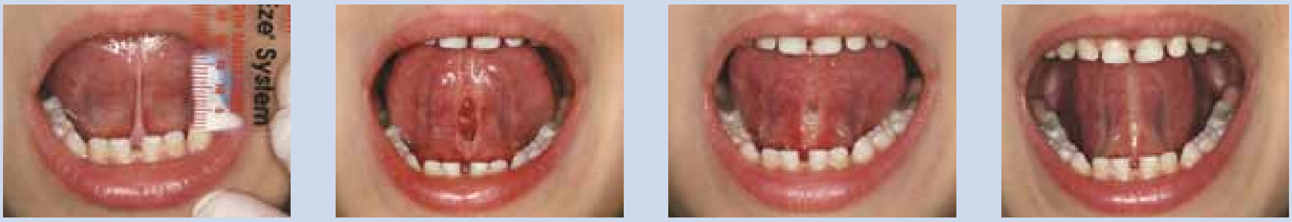

FIG. 1A Male child, 6yrs: diagnostic evaluation of limited opening of the mouth when positioning the tip of the tongue on the palatal papilla, due to short lingual frenum. FIG. 1B Image immediately after Er:YAG laser (2940nm) lingual frenum release (130mJ, 15Hz, 300 µs pulse duration, 600 µ tip, spray on). FIG. 1C One-week post-op image showing healing in progress by second intention with the surgical wound covered by fibrin. FIG. 1D Three-week post-op image showing the almost complete healing and improved function of the oral and lingual muscles.

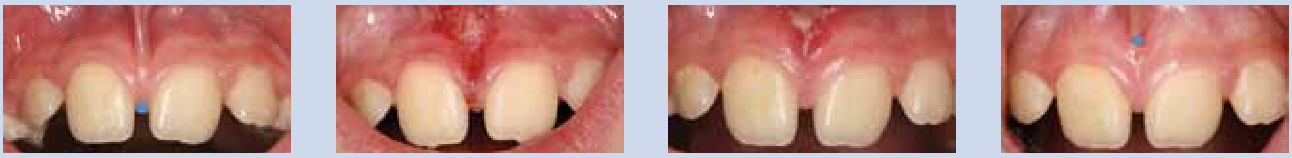

FIG. 2A Female child, 9yrs. presenting anomalous insertion of maxillary labial frenum deeply at the palatal papilla (Class IV). FIG. 2B Minimally invasive Er:YAG laser (2940nm) frenectomy (150mJ, 15Hz, 300 µs pulse duration, 600 µ tip, spray on). FIG. 2C One-week post-op image showing healing by second intention in progress with the surgical wound covered by fibrin. FIG. 2D Three-week post-op image showing complete healing and correct repositioning of maxillary frenum on the mucogingival junction (Class I).

alterations related to the different temperatures that are reached in the tissue and is closely linked to the parameters and techniques used [Miserendino and Pick, 1995]. The temperature rise in the tissue produces a direct and indirect lethal effect on bacterial cells, inducing an important decontaminating effect in the surgical area. Temperature around 100°C produce incision and or vaporisation of the target tissue (gingiva, mucosa, frenulum and oral pathologies). Temperature between 60°–100°C allows for effective coagulation. Temperature above 100 °C produces carbonisation with typical black spots. Together with the wavelength chosen, are also important energy, emission mode, pulse repetition rate, water spray, fluence and operative mode.

Laser in oral pathology

There is limited literature available regarding oral pathology and laser therapy in paediatric dentistry. Most publications refer to clinical reports on adults or include case reports in paediatric dentistry. Both the surgical removal and low-level laser therapy (LLLT) can be used depending on clinical conditions. However, laser treatment of oral benign pathologies has specific application in children for the aforementioned advantages of different laser techniques (Table 2).

Laser application in periodontics

The decontaminating effect of different laser wavelenghts is used for pocket treatment in adults. Both the phothermal effect of near and medium infrared lasers and the photochemical effect of aPDT, result effective as an adjunct to scaling and root planing for the management of aggressive periodontitis [Vohra et al., 2016]. The photothermal effect can also provide curettage of the infected epitelium and induce the formation of a stable fibrin clot at the opening of the pocket [Matarese et al., 2017; Roncati et al., 2017]. However, treatment of young patients affected by juvenile and aggressive periodontitis is scarcely documentated. A study compared surgical traditional treatment to non surgical Nd:YAG laser therapy, and laser resulted as a valid alternative to conventional therapy, in relation to the young age of the patients, expecially in individuals with increased anaesthesiological risk and/or with coagulation and platelet function disorders [Mummolo et al., 2008]. However, more clinical and experimental studies are required to validate this alternative therapy.

Laser application in orthodontics

Many clinical conditions need soft tissue treatment before, during and after orthodontic therapy and the laser is often used for the application reported in Table 3.

These treatments, necessary for the orthodontic therapy or for its completion, are extremely simple, safe and rapid and can be performed by the orthodontist. All wavelengths are indicated for these procedures, albeit with different techniques, according to the different laser tissue interactions of different laser wavelength. Among the many applications of laser in orthodontics, labial frenectomy and lingual frenum release are the most common and documented ones: many authors reported less postoperative pain, discomfort and fewer functional complications (speaking and chewing) compared to the traditional technique, in the population studied, where diode, Nd:YAG, Er:YAG, Er,Cr:YSGG and CO_2 lasers, were used, resulting in a better patient perception of the therapy [Gontijo et al., 2005; Haytac and Ozcelik, 2008; Kara, 2008; Shetty et al., 2008; Olivi et al., 2010; Olivi et al., 2012; Pié-Sánchez et al., 2012; De Santis et al., 2013; Crippa et al., 2016]. Gingivectomy, gingivoplasty, opercolectomy, can be performed easily and without anaesthesia with all

Herpes labialis	[de Paula Eduardo et al., 2014]
Aphtosis	[Han et al., 2016]
Traumatic ulcer	[Kurtulmus-Yilmaz et al., 2015]
Haemangioma	[Angiero et al., 2008; Miyazaki et al., 2013]
Fibroma	[Boj et al., 2014; Olivi et al., 2007]
Papilloma	[Boj et al., 2007a; Boj et al., 2014]
Epulis	[Olivi et al., 2007]
Pyogenic granuloma	[Boj et al., 2006a; Wollina et al., 2017]
Mucocele	[Boj et al., 2009; Paglia et al., 2015]
Eruption cyst	[Boj et al., 2006b]
Dentigerous cyst	[Boj et al., 2007b]
Foreign body removal	[Olivi et al., 2011b]
Retained root fragment removal	[Olivi et al., 2011b]

TABLE 2 Oral pathologies treated with different lasers.

wavelengths, permitting an easy and faster orthodontic workflow.

Conclusion

The use of laser in children oral care is effective, offering several benefits to patient and dentist. Education is mandatory and learning curve can be long; however several postgraduate master degree and proficency courses offer outstanding education on the use of laser technology, improving the knowledge of applied laser physics.

Upper and lower labial frenectomy
Lingual frenum release
Gingivectomy for brakets application
Gingivoplasty after brakets removal
Opercolectomy
Unerupted tooth exposure
Impacted tooth exposure
Biostimulation and pain relief of orthodontic movement

TABLE 3 Applications of laser in orthodontics.

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