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Nd:YAG and Diode Laser in the Surgical Management of Soft Tissues Related to Orthodontic Treatment

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ABSTRACT

***Objective*: The aim of this clinical study was to observe and evaluate the surgical management efficiency of soft tissues during orthodontic treatment. *Materials and Methods*: Thirty-seven young patients were selected and treated by laser-assisted surgery before or during orthodontic treatment and were classified by sex, age, and type of surgical management. Three different wavelengths were used (diode 810 nm, diode 980 nm, and Nd:YAG 1064 nm) in different surgical situations: maxillary vestibular and lingual frenectomies, surgical exposure and alignment of ectopic or retained teeth, and re-contouring gingival overgrowth. *Results*: In all evaluated patients, the laser treatment was performed without local anesthesia or sutures. Only topical anesthetic was needed. *Conclusion*: These use of these wavelengths of laser energy was a noticeable aid in the surgical management of soft tissues before or during orthodontic treatment. The benefits of laser treatment include reduced bleeding during surgery with consequent reduced operating time and rapid postoperative hemostasis, thus eliminating the need for sutures. The lack of need for anesthetics and sutures, as well as improved postoperative comfort and healing, make this technique particularly useful for very young patients.**

INTRODUCTION

THE N:YAG LASER has been used in dentistry since 1970. The active medium is a crystal of yttrium aluminum garnet in which some molecules are substituted with atoms of neodymium. Its wavelength (1064 nm) is well absorbed by melanin and hemoglobin and thus demonstrates a hemostatic effect on soft tissues.[1–6] Diode lasers (using semiconductors) also demonstrate an affinity for hemoglobin due to its wavelength (808 to 980 nm).[7–11] Both Nd:YAG and diode lasers have beam delivery systems that use optical fibers.[12]

Lasers may be used in orthodontics for many parts of treatment:

- Before treatment, to eliminate soft tissue anomalies such as lingual and vestibular frenulum, and to reducing the potential for relapse after the removal of appliances
- During treatment, in the case of retained teeth (operculectomy)
- At the end of treatment, in the case of gingival overgrowth, to correct gingival border contours

The main advantages of laser-assisted surgery are the possibility of reducing or avoiding the use of anesthetics (especially important in pediatric patients), the bloodless surgical field, and reducing postoperative pain. Moreover, suturing is generally not required.[13–14] The so-called bio-stimulation effect could enhance the healing process,[15–18] as may the antimicrobial properties of laser energy.[19–21]

The aim of this clinical study was to illustrate the main advantages that Nd:YAG and diode lasers exhibit in the surgical management of several common types of oral pathology before and during orthodontic treatment, such as:

- Hypertrophic maxillary vestibular frenum can be related to the presence of an interincisive diastema, and this relation can be demonstrated with a traction test (mobilization of the lips); many authors suggest surgically treating this when the size

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of the frenum and density of tissue interposed between central incisors cause a very large diastema (6–8 mm).[22–23]

- Ankyloglossia or tongue-tie, classified according to its degree by Kotlow and associates, that reduces mobility and capability to raise the tongue.[24–30]
- Retained teeth, a common condition seen in clinical practice (frequency of retention of canines ranges from 4.3–0.92%).[31–37]
- Gingival overgrowth, which can occur during orthodontic treatment, particularly when spaces are rapidly closed and oral hygiene is poor as shown by chronic inflammation of the soft tissues.[38–43]

TABLE 1. CHARACTERISTICS OF THE PATIENTS TREATED IN THIS STUDY

Parameter		*No.*
By gender	Male	17
	Female	20
By age	<6 years	2
	6–10 years	24
	10–14 years	6
	14–18 years	4
	>18 years	1
By pathology	Maxillary vestibular frenum	12
	Lingual frenum	5
	Retained teeth	14
	Gingival hyperplasia	6

MATERIALS AND METHODS

Patient selection

Thirty-seven young patients were selected and treated by laser-assisted surgery before or during orthodontic treatment. They were classified by sex, age, and type of surgical management (Table 1).

Before laser surgery, a topical anesthetic (EMLA; AstraZeneca, Wilmington, DE) was applied to soft tissues, and no other local anesthetic was used. No sutures were used at the end of surgery.

Laser parameters

Parameters of irradiation are summarized in Table 2.

CLINICAL REPORTS

Maxillary vestibular frenum

Clinical case 1 Patient C.S. She was an 11-year-old girl with a vestibular frenum associated with an interincisive 5-mm diastema (Fig. 1a). The traction test was positive. A laser-assisted frenectomy was performed using a diode laser Oral-Laser Jet 20 (Oralia) using the parameters shown in Table 2 (Figs. 1b and 1c). There was no need for antibiotics or anti-inflammatory drugs, and the healing process was rapid (Fig. 1d). Orthodontic therapy was begun with a fixed sectional appliance limited to the anterior teeth and was completed in 3 months. A splint was then applied for 6 months on the palatal surfaces of the central incisors (Fig. 1e).

Clinical case 2 Patient S.G. She was a 9-year-old girl with a maxillary vestibular frenum associated with a large interincisive diastema (Fig. 2a).The laser-assisted frenectomy was performed using the Nd:YAG laser (Fotona Fidelis Plus) using the settings described in Table 2 (Figs. 2b and 2c). The healing process was uncomplicated and completed in 1 week (Fig. 2d). Three weeks later, the tissues had returned to normal (Fig. 2e), and an appliance was affixed to close the diastema and derotate the incisors. After 3 months, gingival hyperplasia was present around upper incisors, most likely due to poor oral hygiene (Fig. 2f). Another laser-assisted surgical procedure was performed with a diode laser (Oral-Laser Jet 20) (Fig. 2g). Two weeks later, the tissues had returned to normal, and 1 month later the fixed appliance was removed and a removable appliance was placed (Fig. 2h).

Clinical case 3 Patient T.A. This was a 10-year-old girl with a gummy smile (Fig. 3a). An upper vestibular frenum without interincisive diastema was observed (Fig. 3b). A laser-assisted frenotomy (diode LASEmar 900 Eufoton) was performed to eliminate the muscular fibers from the upper lip to the alveolar gingiva using the previously described parameters (Fig. 3c). After 1 week, the healing process was observed (Fig. 3d), and 3 weeks later, the patient began speech therapy to lengthen the upper lip. A clinically satisfactory result was obtained 6 months later (Fig. 3e).

Lingual frenum (Table 3)

Clinical case 4 Patient V.L. This was an 8-year-old girl with severe ankyloglossia plus atypical deglutition (third class) (Fig. 4a). Unable to complete speech therapy, this patient was referred to the dental clinic. The laser-assisted surgery (diode LASEmar 900 Eufoton) was performed using the settings de-

TABLE 2. LASER PARAMETERS

Laser	*Wavelength*	*Output power*	*Frequency*	*Emission mode*	*Delivery system*	*Power density*
Diode (Oral-Laser Jet 20 Oralia)	810 nm	20 W	10.000 Hz	On/Off ratio = 1:7	Optical fiber (400 μm)	1600 W/cm^2
Diode (LASEmar 900 Eufoton)	915 nm	3.5 W		CW	Optical fiber (320 μm)	4354 W/cm^2
Nd-YAG laser (Fotona Fidelis Plus)	1064 nm	5 W	40 Hz	Pulsed	Optical fiber (320 μm)	6229 W/cm^2

a b c d

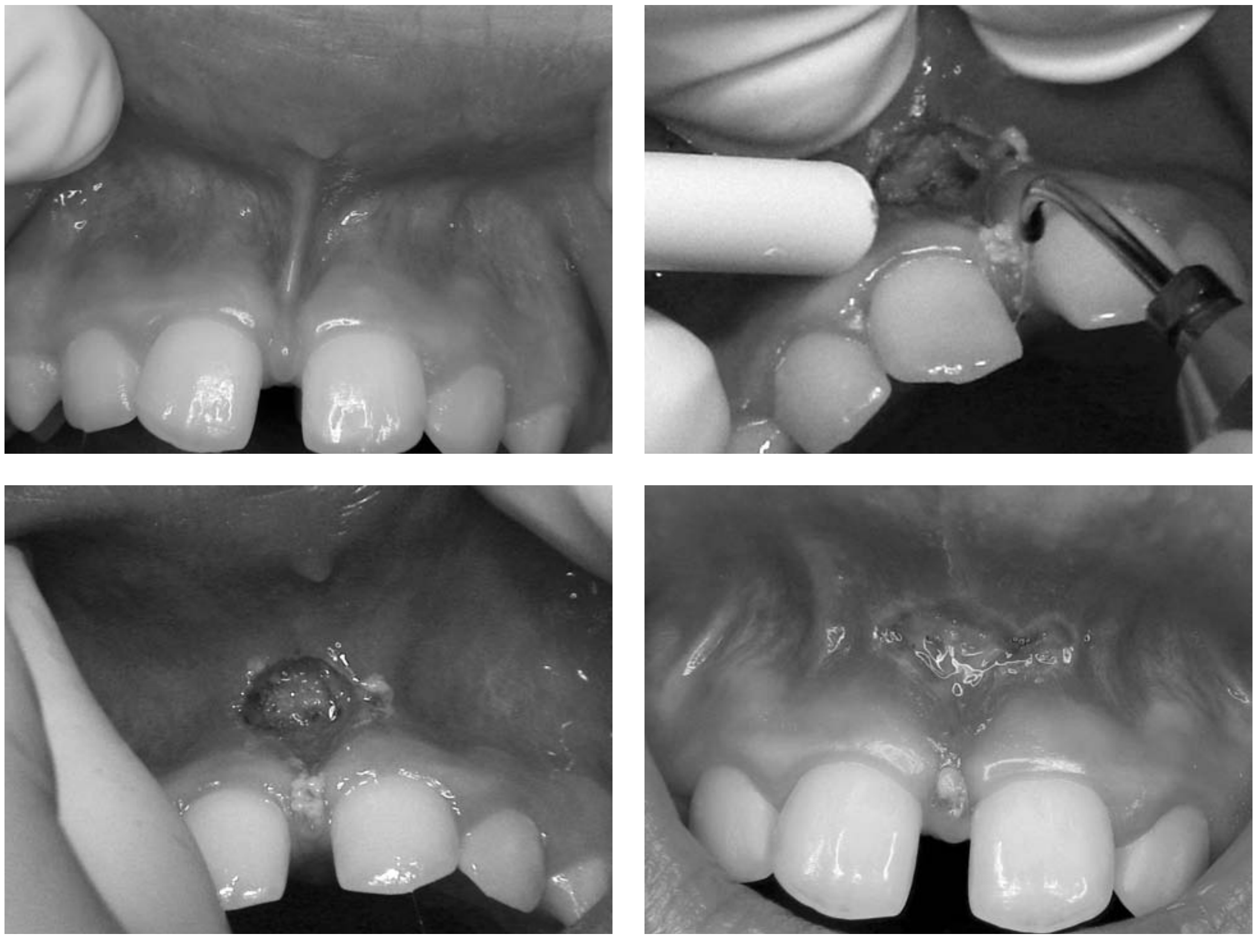

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FIG. 1. (**a**) Vestibular frenum associated with an interincisive 5-mm diastema. (**b**) Laser-assisted frenectomy using the diode laser. (**c**) Clinical aspect immediately after frenectomy. (**d**) Healing 1 week after surgery. (**e**) Clinical appearance after orthodontic treatment.

scribed in Table 2 (Fig. 4b). After 1 week, healing was progressing without complication (Fig. 4c). One month later, the tissues had returned to normal (Fig. 4d), and the patient could start functional re-education.

Retained teeth

Clinical case 5 Patient M.T. This was a 14-year-old girl with a retained upper permanent left canine (Fig. 5a). A fixed appliance was placed on the upper arch to prepare the maxillary teeth and to make a sufficient space (Fig. 5b). Three months later, laser-assisted surgery using the diode laser (Oralia Jet 20) was performed to expose the canine crown and bond a bracket for future traction (Figs. 5c and 5d). After 10 months, the canine was completely aligned on the arch (Fig. 5e). After 12 months, the appliance was removed with a good result (Fig. 5f).

The use of laser technology in the treatment of retained teeth demonstrates several advantages. It permits a strictly selective intervention which is minimally invasive and preserves the pea b c d e f g h

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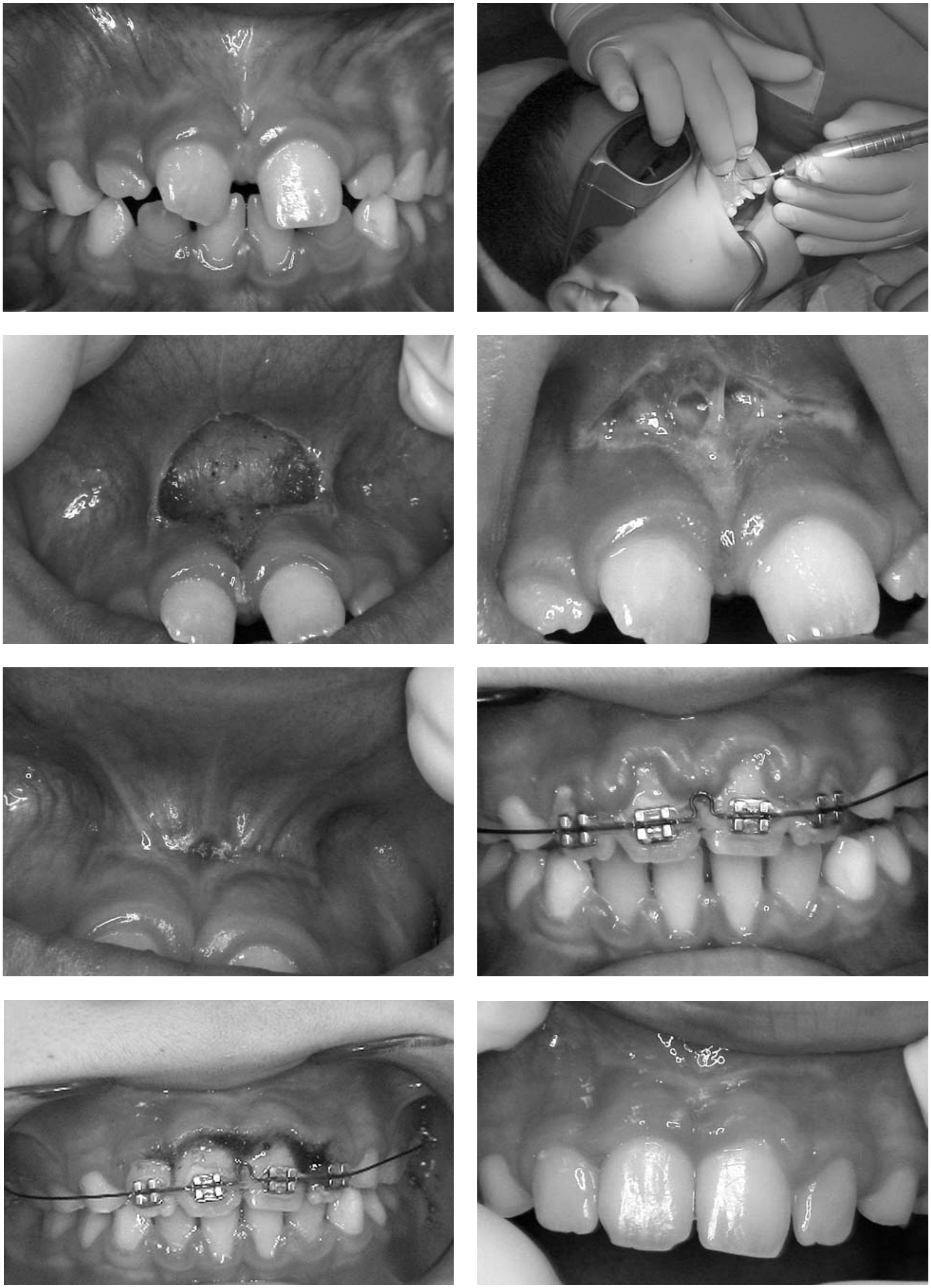

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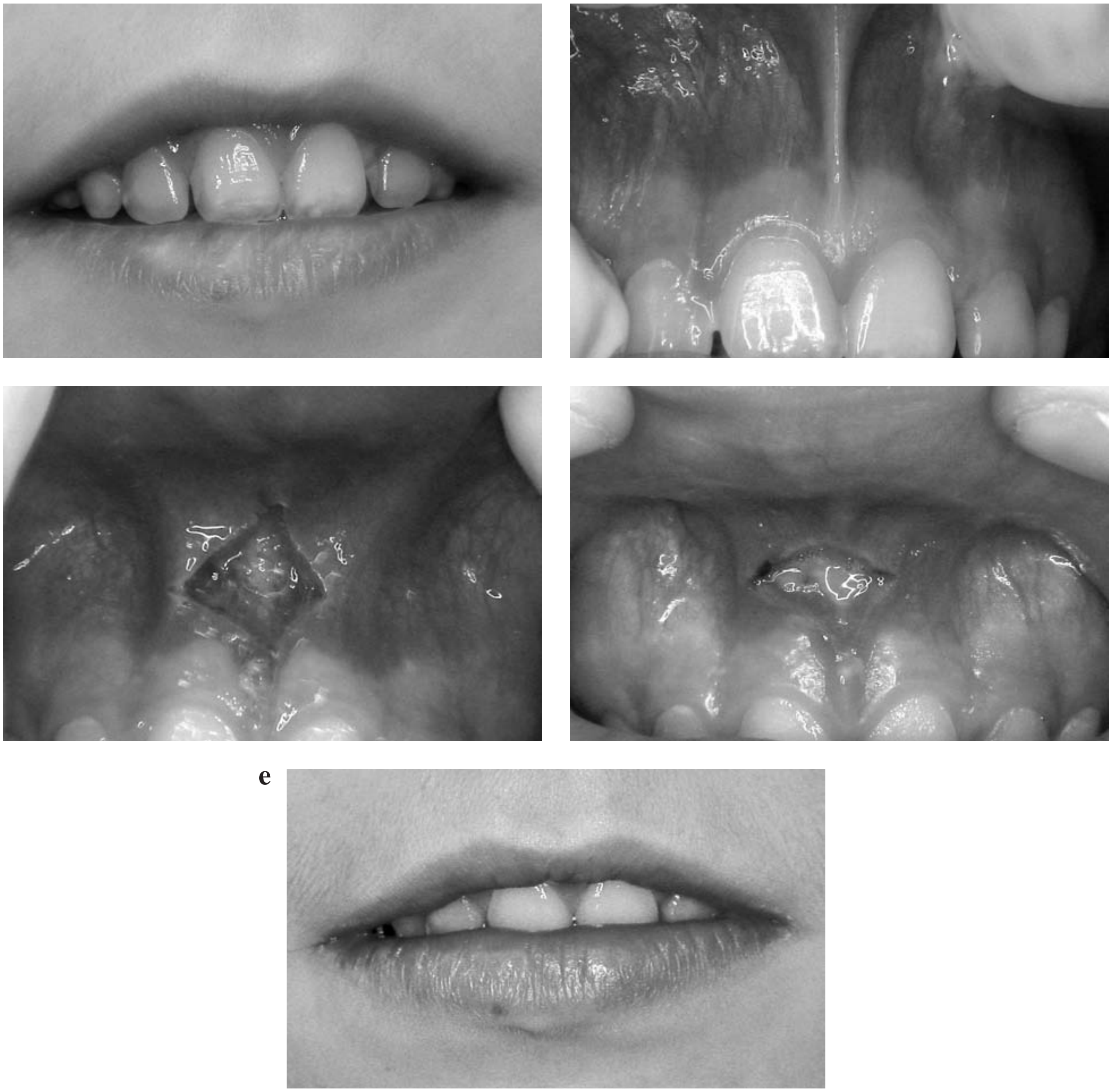

FIG. 3. (**a** and **b**) Gummy smile and hypertrophic vestibular frenum in a 10-year-old child. (**c**) Laser-assisted frenectomy using the diode laser. (**d**) Healing 1 week after surgery. (**e**) Clinical appearance 6 months after surgery.

FIG. 2. (**a**) Vestibular frenum associated with an interincisive large diastema. (**b** and **c**) Laser-assisted frenectomy using the Nd:YAG laser. (**d**) Healing 1 week after surgery. (**e**) Healing 3 weeks after surgery. (**f**) Gingival overgrowth probably due to the poor oral hygiene. (**g**) Laser-assisted gingivectomy using the diode laser. (**h**) Healing 1 month after gingivectomy.

Table 3. Kotlow Classification of Degrees of Ankyloglossia

	Distance from insertion of frenum to tip of the tongue
Clinically acceptable	>16 mm
First class: Mild ankyloglossia	12–16 mm
Second class: Moderate ankyloglossia	8–11 mm
Third class: Severe ankyloglossia	3–7 mm
Fourth class: Complete ankyloglossia	<3 mm

riodontium. Another advantage is the complete absence of bleeding. Subsequently it is possible to extemporaneously bond the bracket, preventing the risks of debonding and reducing the need for re-intervention.

Clinical case 6 Patient A.V. This was a 13-year-old boy with bilateral inclusion of maxillary permanent canines (Fig. 6a). A fixed appliance was bonded for tooth alignment to obtain sufficient space and move the canines into the arch (Fig. 6b). After 2 months, laser-assisted surgery (Nd:YAG laser, Fotona Fidelis Plus laser) was performed to expose the canine crowns and seal the brackets (Fig. 6c). Six months later, a second surgical procedure using the diode laser (LASEmar Eufoton 900) was necessary to expose vestibular crowns and bond brackets for the alignment of the canines (Figs. 6d, e, and f). Four months later, the teeth were aligned in the arch (Fig. 6g).The fixed appliance was then removed with a good clinical result (Fig. 6h).

Clinical case 7 Patient D.M. This was a 14-year old boy with agenesis of the permanent upper right lateral incisor and inclusion of the permanent upper right canine (Fig. 7a). A fixed appliance was applied to the upper arch to align the teeth (Fig. 7b). After 2 months, a laser-assisted procedure (Nd:YAG Fo-

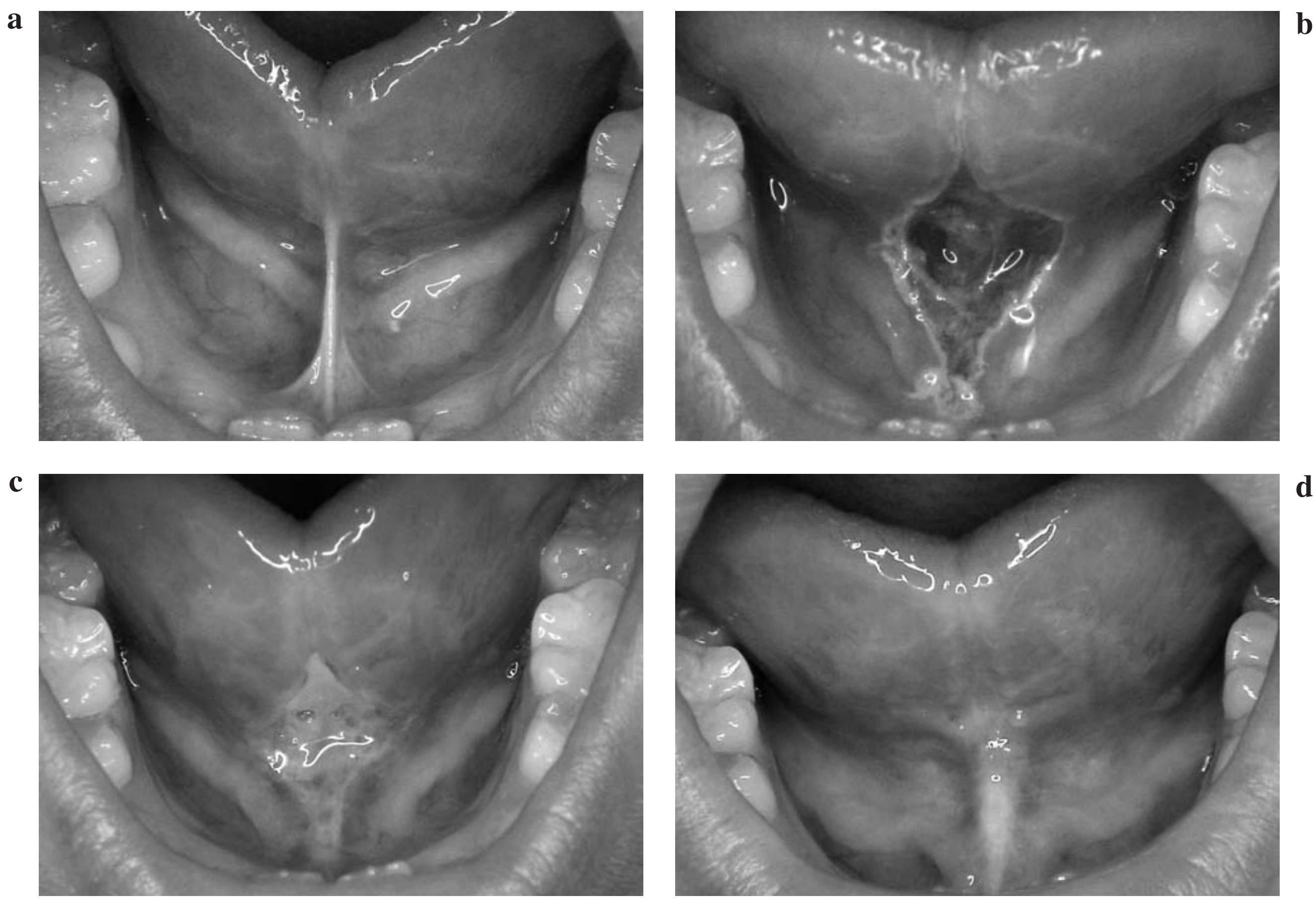

FIG. 4. (**a**) Severe ankyloglossia in an 8-year-old child. (**b**) Laser-assisted surgery using the diode laser. (**c**) Healing 1 week after surgery. (**d**) Healing 1 month after surgery

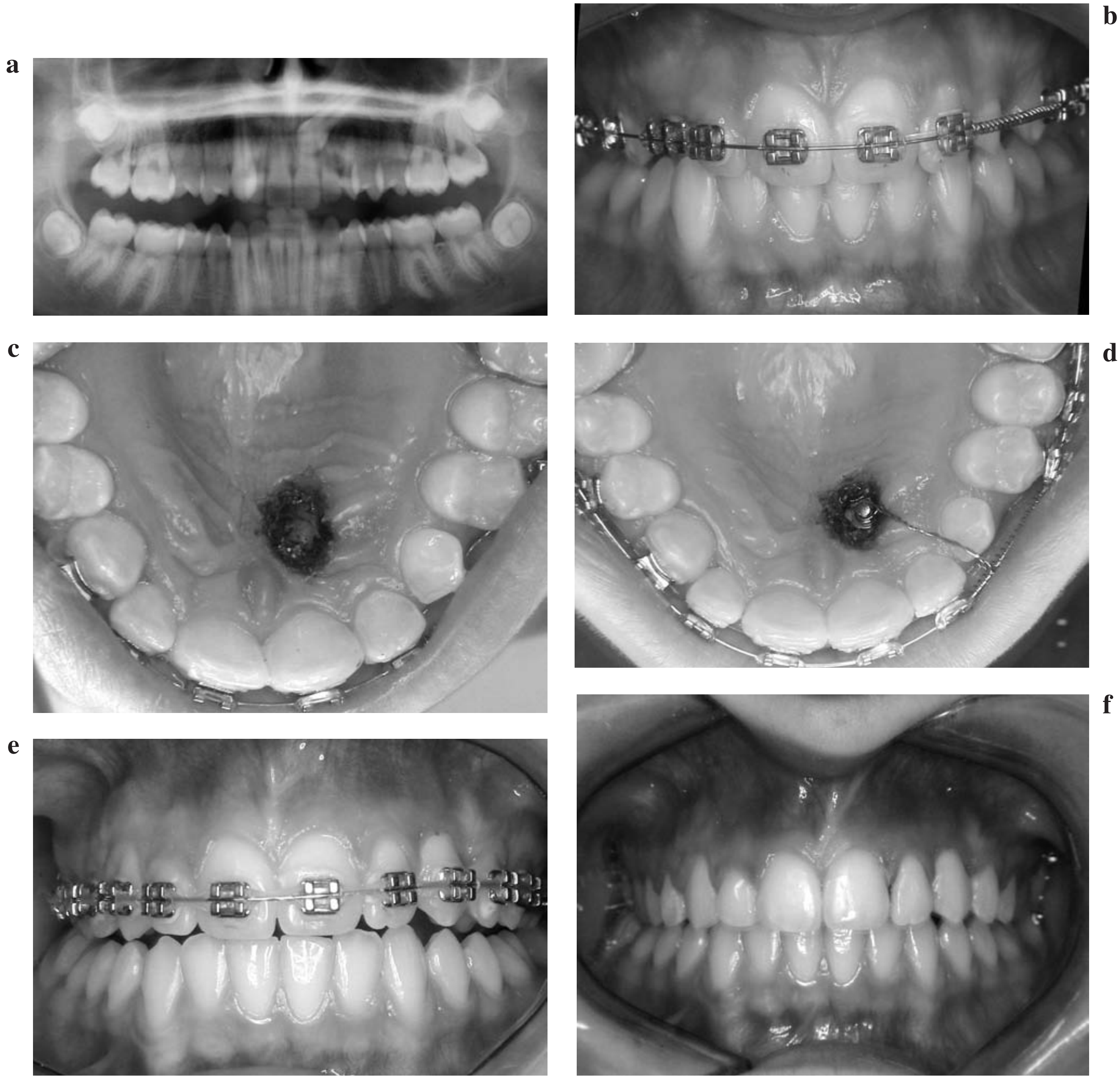

FIG. 5. (**a**) Radiological view of a retained upper permanent left canine. (**b**) Fixed appliance placed on the upper arch. (**c**) Laser-assisted surgery using the diode laser. (**d**) Canine-bond bracket. (**e** and **f**) Clinical result 10 and 12 months after surgery.

tona Fidelis Plus) was performed to expose the crown of the canine and apply a bracket for traction (Figs. 7c and 7d). After 6 months, the tooth was aligned in the arch and a space was opened for insertion of a temporary bridge (Fig. 7e). After 3 months, the appliance was removed and a fixed prosthetic was placed (Figs. 7f, g, and 7h).

Gingival overgrowth

Clinical case 8 Patient R.A. This was a 10-year-old girl in orthodontia. During treatment with a fixed appliance, significant gingival hyperplasia affected the upper arch (Fig. 8a). A laser-assisted procedure was performed (Nd:YAG laser, Fotona Fidelis Plus) (Fig. 8b). After 2 weeks (Fig. 8c) and after 2 months, when the brackets were removed (Fig. 8d), the gingival situation was satisfactory.

CLINICAL RESULTS

The follow-up for each patient consisted of several clinical and control visits at 1 week, 2 weeks, and 1 month after sur-

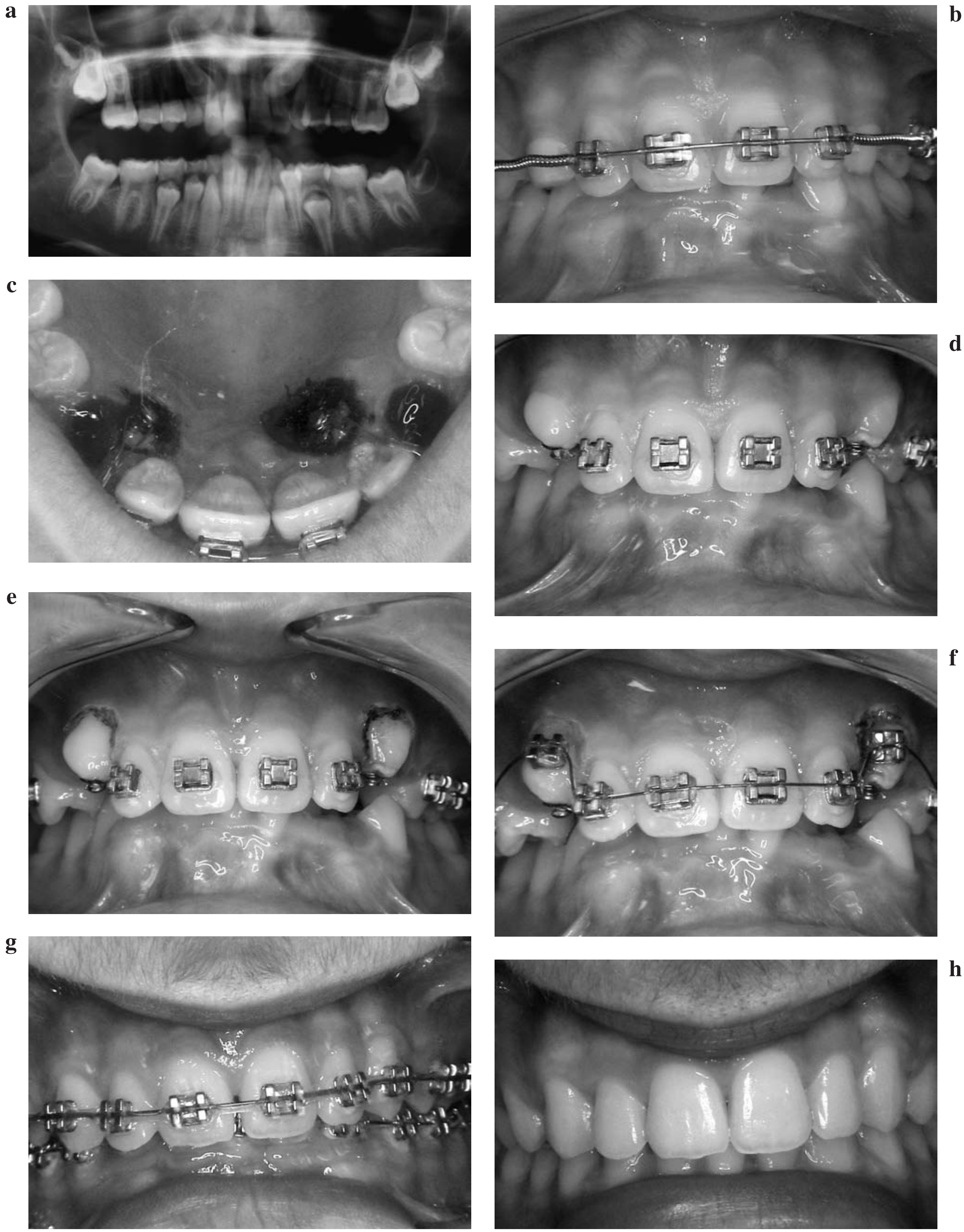

FIG. 6. (**a**) Radiological view of bilateral retention of maxillary permanent canines. (**b**) Fixed appliance for tooth alignment. (**c**) Laser-assisted surgery was performed. (**d, e,** and **f**) Second surgery was necessary to expose the canine crowns. (**g** and **h**) Clinical appearance before and after the fixed appliance was removed.

a b c d e f g h

FIG. 7. (**a**) Radiological view of permanent upper right lateral incisor agenesis and retention of the upper right canine. (**b**) Appliance fixed to the upper arch to align the teeth. (**c**) Laser-assisted surgery using the Nd:YAG laser. (**d**) Bracket application. (**e**) Insertion of a temporary bonded bridge. (**f** and **g**) After 3 months a fixed prosthetic was bonded. (**h**) Final clinical result.

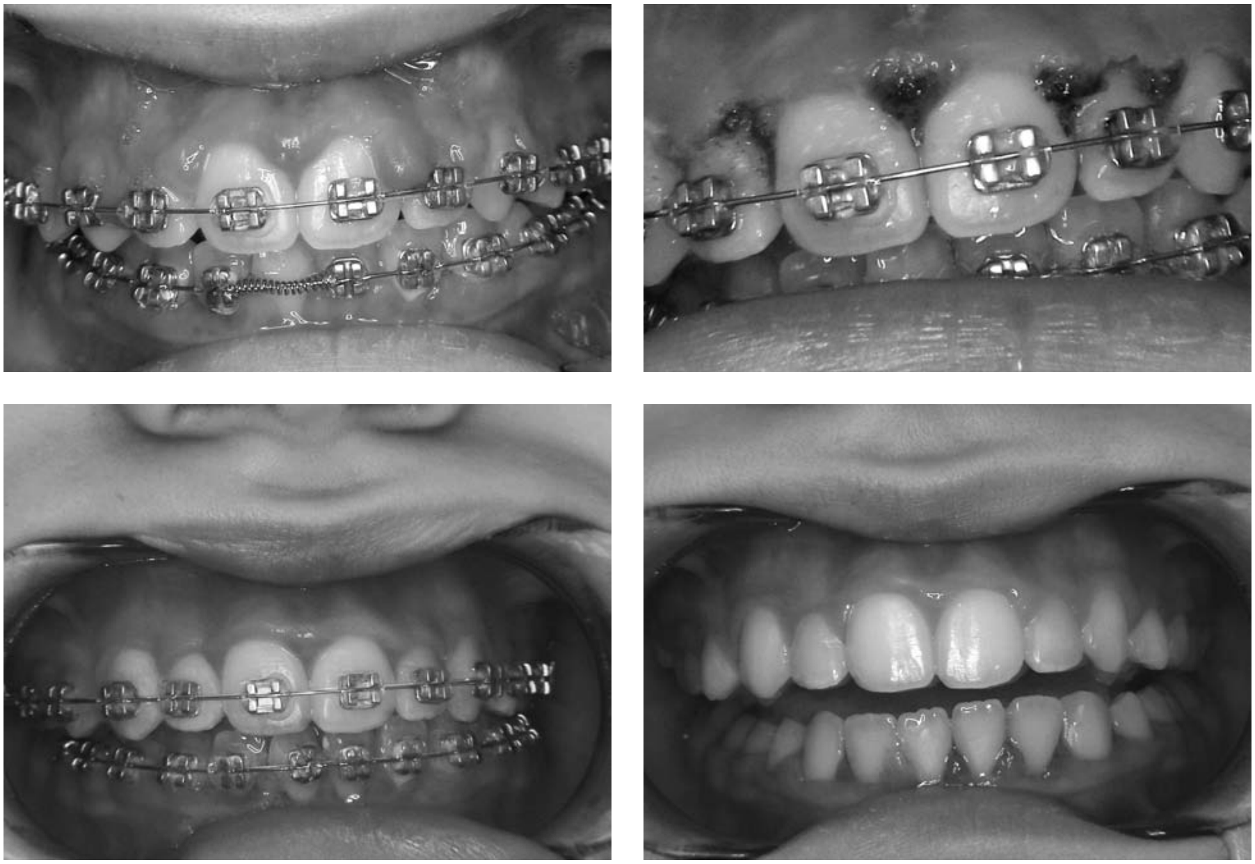

FIG. 8. (**a**) Gingival overgrowth in the upper arch. (**b**) Appearance after laser-assisted gingivectomy with the Nd:YAG laser. (**c**) Healing after 2 weeks. (**d**) Healing after 2 months and after bracket removal.

gery, then every month until the end of orthodontic treatment and every 6 months after treatment for a period of 2 years.

During the first control visit, an examination of postoperative recovery was performed by means of a simple questionnaire, which had questions about the presence of pain and its intensity, the need for analgesics, the presence of discomfort when eating, and presence of postoperative bleeding. All patients reported the absence of both pain and eating discomfort, and none reported bleeding.

During the subsequent control visits, the clinician's attention was focused on adequate healing of the surgical site, the absence of relapse, and evaluation based on clinical and radiological analysis. In all patients the healing process proceeded without delay or relapse.

DISCUSSION

The use of laser surgery has several important advantages for oral soft tissue surgery procedures, particularly when using diode and Nd:YAG lasers, due to their high absorption by chromophores such as hemoglobin, melanin, and collagen, and their ability to cut while also effecting coagulation and hemostasis. As reported in recent scientific papers,[44–46] the benefits of laser treatment include:

- Reduced bleeding during surgery with consequent reduced operating time and excellent visualization of the operating field.
- Rapid postoperative hemostasis.
- The avoidance of any need for local anesthetics and sutures, as well as avoiding the unpleasant experience of suture removal 1 week after surgery, when the sutures may be buried in the mucosa.
- Increased postoperative comfort, due to the absence of the unpleasant taste of blood and the unattractive appearance of sutures, which both can result in a lack of a sense of well-being in the postoperative period.
- Rapid healing due to the biostimulating and antimicrobial properties of laser energy.

However, it must also be considered that there are some limitations on the use of oral laser surgery in clinical practice, including:

- The need for understanding of the laser's physical characteristics and laser-tissue interaction, in order to avoid damage and to use the laser in a safe manner.
- The necessity to correctly train the staff to observe safety rules (e.g., use of goggles).

- The cost of laser surgery is higher than that of traditional surgery.

CONCLUSION

These clinical observations suggest that laser technology may be utilized for surgical management of soft tissues during orthodontic treatment in various situations, with many advantages, particularly in very young patients, in whom surgical intervention including use of local anesthesia and suture placement can result in increased postoperative pain and discomfort, which has a great impact on patient compliance.

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