Table 1. Review of published data in using dental lasers for different kinds of soft tissue incisions.

	Author/year	Method/clinical application	Laser type	Conclusion
1	Wilder-Smith et al 1995 (11)	Soft tissue incision (oral mucosa of pig's mandible)	CO_2	Thermal and histologic results were related to parameters and beam characteristics rather than wavelength. Minimal edge coagulation artifact observed. minimal to no hemorrhage and re-epithelialization and collagenization were found to occur by day 7 in both laser and conventional groups.
2	Rizoiu et al 1996 (12)	mucocutanous soft tissues incision	Er,Cr:YSGG	
3	White et al 1998 (9)	Excision of oral mucosa lesions(leukoplakia,lichen planus, squamous papilloma, pyogenic granuloma,…)	CO_2 and Nd:YAG	Laser excision was well tolerated by patients, All patients healed post surgically with no loss of function, minimal postoperative pain, conservative site-specific minimally invasive surgeries, and elimination of need for sutures.
4	Goharkhay et al 1999 (1)	Soft tissue incision	Diode laser (810 nm/0.5-15 w/pulse rate of 2-32zone. Excellent coagulation ability, useful alternative msec/1.5-250 Hz)in soft-tissue surgery of the oral cavity.	Remarkable cutting ability and the tolerable damage
5	Neiburger et al 1999 (13)	gingival flap incisions	1.4 mw helium-neon (670 nm) diode laser for 30seconds (fluence = 0.3469 J/cm2).	helium-neon diode lasers, at the mentioned energy level, increase the rate of gingival wound healing in percent of patients, without any side effects.
6	Wilcox et al 2001 (14)	Use of electrosurgery and lasers in the presence of dentalunit, a bipolar implants (in vitro study)	a unipolar electrosurgical unit, and Nd:YAG.	Use of the unipolar electrosurgical unit should be avoided, while judicious use of both the bipolar unit and or the laser unit should produce temperature profiles well within clinical limits.
7	Gontijo et al 2005 (15)	labial frenectomy in infant patients.	diode (810 nm) and Er:YAG	a combined technique is suggested: using the diode laser in soft tissues and the Er:YAG laser in periosteal bone tissues and for removal of final collagen fibers.
8	Haytac et al 2006 (16)	frenectomy	CO_2	Compared with scalpel technique it shows less postoperative pain and fewer functional complications (speaking and chewing). required fewer analgesics. safe, effective, acceptable, and impressive alternative for frenectomy operations.
9	Boj et al 2007 (17)	Squamous cell papilloma removal in the pediatric dental office.	Er,Cr:YSGG laser	No pain medication was required after surgery, wound healing was excellent and rapidly achieved. The oral pathology report confirmed the pre surgical clinical diagnosis.
10	D'Arcangelo et al 2007 (18)	incisions in rat oral tissue	diode (808 nm)	Diode laser tends to produce more pronounced changes than conventional scalpel surgical procedure (due to tissue thermal damage), with corresponding greater inflammatory reaction and delay in tissue organization only at the initial stage.
11	Shetty et al2008 (19)	Maxillary frenectomy in a pediatric patient.	CO_2	A successful case of a maxillary labial frenectomy in a pediatric patient .
12	Capodiferro S et al 2008 (20)	excision of fibrolipoma of the lip	Diode	the diode laser is undoubtedly a good alternative to conventional surgery. possibility of avoiding direct suture is surely helpful in aesthetic areas. The wound healed excellently and rapidly without sutures. No relapse was observed a year after the surgery.
13	Boj et al 2009 (21)	Lower lip mucocele treatment	Er:YAG	Minimal damage to surrounding tissue.
14	Iseri et al 2009 (22)	epulis fissuratum and prosthetic rehabilitation in patients with vesiculobullous disease.	CO_2	Treatment of
15	De Arruda Paes-Junior et al 2010 (23)	Treatment of epulis fissuratum	CO_2	Good haemostasis, no infection, post-operative comfort, esthetic and functional aspects immediately reestablished.
16	Tuncer et al 2010 (24)	Intra oral soft tissue excisional biopsies	CO_2	Minimal interoperative and postoperative complications , good pain control.

Table 1. (Continue)

	Author/year	Method/clinical application	Laser type	Conclusion
17	Cercadillo-Ibarquren et al 2010 (25)	In vitro study on porcine oral mucosa samples, evaluation of thermal damage (1w with & without water/air spray,)	CO_2 (1w, 2w, 10w, 20w)-Diode(2w, 5w, 10w pulsed)-Er,Cr:YSGG	The wavelength of each laser determines the absorption rate of every tissue and the thermal effect
18	Vescovi et al 2010(26)	Hyperplastic fibroepithelial lesions excision.(buccal mucosa)	Nd:YAG (3.5 w, 60 Hz) and Nd:YAG (5w, 30 Hz)	Better incision quality and less width of overall tissue injuries in use of higher frequency and lower power.
19	Jin et al 2010 (27)	Wound healing following incision in guinea pig oral mucosa	Diode laser	Er,Cr:YSGG laser	Diode laser is considered a good cutting device for oral mucosa.
20	Gomez-Santos et al 2010 (28)	Irradiation of different implant surfaces	CO_2 (4 W) and an ErCr:YSGG laser (1.5 W, pulsed mode)	The acid-etched and sandblasted surfaces were those most affected by the thermal changes.
21	De Oliveira Guare et al 2010 (29)	Drug-induced gingival enlargement treatment (gingivectomy)	gallium-aluminum-arsenide (GaAlAs) diode laser	A diode laser was used as an effective and safe method to remove the patient's overgrown gingival tissue in a two year follow up.
22	Pedron et al 2010 (30)	Excision of mucocele of the lower lip.	high-intensity diode laser	rapid, bloodless, and well accepted by patients. Postoperative problems, discomfort, and scarring were minimal.
23	Lee et al 2010 (31)	laser-aided circumferential supracrestal fiberotomy	laser-aided procedures, when used at appropriate 10 Hz); diode laser (808 wave); and CO_2 laser (10.6 mm, 3 W).	Er:YAG laser (100 mJ, laser settings, preserve the original morphology and chemical composition of cementum.nm, 1.2 W,continuous
24	Arnabat-Dominguez et al 2010 (32)	second-stage implant surgery in patients with insufficient gingival attachment.	Er,Cr:YSGG	laser minimized postoperative pain, and the time to prosthetic rehabilitation was also shortened. The esthetic results were far superior, and no complications were recorded.
25	Boj et al 2011 (33)	Crown lengthening, exposure of an unerupted molar, lingual and maxillary frenectomies,…	Er,Cr:YSGG laser	All cases healed satisfactorily and were followed up for 3 to 4 years.

implant surfaces. According to Arnabat-Dominguez et al application of Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er, Cr: YSGG) laser in the 2nd stage of implant surgery in patients, minimized postoperative pain, and the time to prosthetic rehabilitation was also shortened. The esthetic results were far superior, and no complications were recorded (32). When the Er, Cr: YSGG was used with a water spray, a decrease in temperature was observed in all implants. The acid-etched and sandblasted surfaces were those most affected by the thermal changes. Er, Cr: YSGG laser with a water spray applied to the sealing cap, or the coronal zone of the implants does not generate thermal increments in the apical surface capable of adversely affecting osseointegration and the integrity of the peri-implant bone tissue (28).

Cercadillo_Ibarguren et al histologically evaluated the thermal damage produced in soft tissue by CO_2, Er, Cr: YSGG and diode lasers and showed that the samples with lowest thermal damage were those irradiated with Er, Cr: YSGG laser using water/air spray, followed by CO_2 and diode lasers (25). In addition, Vescovi et al showed that Nd: YAG laser induced serious thermal effects in small specimens (mean size < 7 mm) independently from the frequency and power employed. Better incision quality and less width of overall tissue injuries were observed in the use of higher frequency and lower power (26).

There are different findings about the healing process after using different dental lasers. Jin et al showed that CO_2 laser leads to less tissue damage than a scalpel or Er,Cr:YSGG laser. (27) D'Arcangelo et al. evaluated that diode laser at a power output of 6 W showed the worst results of tissue repair, especially after 7 days. On the contrary, the extent of epithelial damage lateral to the wound edge and the extent of collagen denaturation were near equal with scalpel incision and laser irradiation at 4 W after 14 days. There was a greater concentration of endothelial nitric

oxide synthase (eNOS) and inducible nitric oxide synthase (iNOS) after 7 days of laser surgical procedure. Diode laser tends to produce more pronounced changes than conventional scalpel surgical procedure (due to tissue thermal damage), with corresponding greater inflammatory reaction and delay in tissue organiza tion only at the initial stage (18).

Conclusion

Because of their rapid operations and regular wound healing without sutures, lasers apply a great technology and are useful for soft tissue surgery in modern dentistry. In spite of all these advantages of using lasers in soft tissue incisions, there are not enough data to support the theory of reducing the healing time using lasers. Cost and the site of the laser device may be the biggest obstacles for its routine application.

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