Perfect soft tissue management in the oral use

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_The use of alternating electric current for bloodless interventions in the oral soft tissues has been established for nearly a century, first in the form of the electric knife, then later in the form of radio frequency devices. Laser devices have been introduced in the 1980s as new, additional tools and have become significantly more important until today.

Both of the two technologies are based on the local, rapid heating of the cells in the tissue, and they can be used for cutting and for coagulating.

With the introduction of the laser, however, an almost antagonistic "argy-bargy" was common in marketing. For decades, the manufacturers of lasers and radio frequency devices argued about who can provide the better method for oral soft tissue treatment: "Laser is better than radio frequency"—"Radio frequency is better than laser"—"But with laser you get better results if the power is high enough"—"But if the power is too high, a laser is hardly to control" —"But with special pulse techniques, the thermal damage can be controlled"—"The cutting speed with a laser is already limited, it is much slower than radio frequency. And with pulse technique, it will then slow down again".

Fig. 1_The combination of a diode laser and radio frequency technology offers a wide range of applications.

	Laser	High Frequency	L + HF
Oral surgery	(yellow)	(green)	(green)
Periodontics	(green)	(yellow)	(green)
Implantology	(green)	(yellow)	(green)
Endodontics	(green)	(red)	(green)
Bleaching	(green)	(red)	(green)
PDT	(green)	(red)	(green)
LLLT	(green)	(red)	(green)

However, combining a diode laser with a modern radio frequency generator will make competition obsolete, but you will then have a useful and perfect tool for the soft tissue management. With a laser, the relatively thin and complicated oral tissue can be treated selectively and shows successful results in periodontics, endodontics and implant surgery. The radio frequency technology, on the other hand, simply because of the much higher cutting speed and perfect coagulation, brings about benefits for oral surgery. Photodynamic therapy (PDT), low level laser therapy (LLLT) and the use of the laser for tooth bleaching open additional new treatment options (Fig. 1).

_Why is this approach so promising?

Lasers have been and still are often understood and advertised as general purpose devices. However, there are many applications that cannot be carried out satisfactorily with these devices. Of the many lasers that have been "tried out" in the oral soft tissues for decades, such as the CO_2 laser, the Nd:YAG laser and diode lasers, essentially only the latter can prevail in the market because of their broad spectrum of treatment and their relatively inexpensive equipment designs.

Its strength lies in its applications in periodontics, endodontics and the removal of the superficial soft tissues such as overgrown implants.

A significant disadvantage, however, can be observed in surgical applications. The oral tissue is very thin, delicate and has complicated structures. In addition, it is often in close proximity to jaw bone and tooth structure. While laser radiation is absorbed in the tissue and converted into heat, it will also be partly transmitted through the tissue. It can thus cause unpredictable and undesired side effects in adjacent healthy areas. The cutting speed of the laser beam is limited by the fact that the tissue can be removed only in layers. Neither increasing the laser power nor using laser pulses can eliminate this problem.

However, in radio frequency technology, the tissue will be heated and cut simultaneously, homogeneously and rapidly in the entire length of the inserted metal electrode. Damages to adjacent healthy areas are unlikely and if they do occur, they are predictable and can be planned.

The relatively low frequencies (200 to 400 kHz) in high frequency devices used in human medicine usually generate distinct thermal necrosis with extended healing times, increased swelling and tissue retractions as sequelae. They have been used in dentistry for many years, but they have been replaced by modern radio frequency technologies with working frequencies of 2 to 4 MHz.

_Which are the similarities between diode laser and the radio frequency and what makes them different?

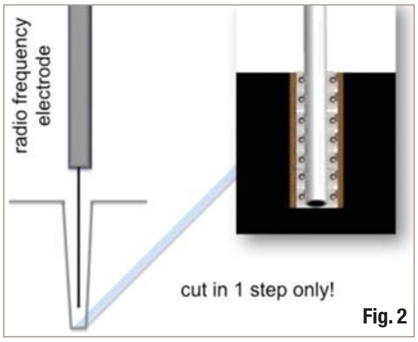
Similarities

Both the laser light from the diode unit as well as the electric current from the radio frequency device are transformed in the tissue to heat. The cells in the tissue will be heated in a fraction of a second, this results in a cut or in a coagulation. While in the laser the power is passed through an optical fiber to the site and the light energy emitts from the fiber tip, in the radio frequency the high-frequency current is directed through a metal electrode into the tissue.

The main difference

A laser fiber a priori can not be inserted deeply into the tissue to produce a cut. The laser radiation emitts from the front end of a fiber and heats only the uppermost layer of the tissue and ablates it. To get into the depth therefore, the tissue must be removed layer by layer (Fig. 2).

In contrast, the metal electrode at the high frequency can be introduced into the tissue in a desired depth. The RF field heats the area simultaneously and uniformly to the entire physical length (Fig. 3). The cutting speed of the RF electrode therefore is much faster than with a diode laser. Also, in the intraoral use of radio frequency technology it is very positively accepted that the local increase in temperature is less than 60 to 80 °C. Using a laser or an electric knife, however, a temperature increase of more than 400 °C must be considered.



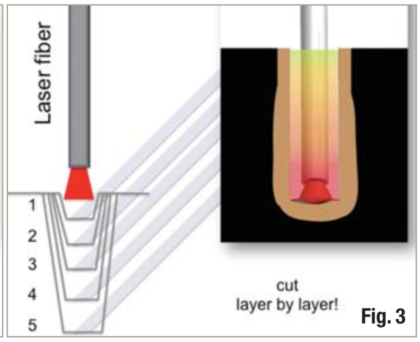


Fig. 2_Cutting in tissue with a diode laser. The tissue cut is removed layer-by-layer. The deeper the cut, the greater is the heat damage at the base of the lesion. The emitted laser radiation also heats the fiber end, thus the tissue is exposed to additional stress.

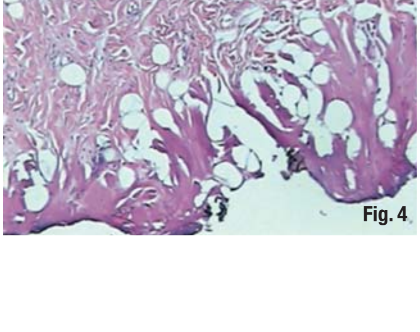
Fig. 3_Cutting of tissue with radio frequency: The tissue is removed by only one precise, uniform section in the entire length of the inserted electrode. The metal electrode remains cold at 2.2 MHz.

In a leukoplakic, exophytic growing alteration at the left border of the tongue, the histology after the use of radio frequency at 2.2 MHz shows just little thermal damage in the striated muscle (Fig. 4). The thermal reaction layer in the stroma is minimal, vacuoles are invisible.

Figure 5 shows a histological comparison of the thermal reaction zone in an excidate, which was removed using a 980 nm laser. Recognisable is the much wider and partially merged reaction zone as a result of the significant thermal effect.

_The situation in dentistry

The estimated more than 20 providers of diode lasers use mostly marketing arguments such as laser wavelength, performance and the possibility of using pulses. A jour, wavelengths of 810 nm and 980 nm are advertised, although there are only very small differences. Thus, for example, 980 nm shows a higher absorbance in water, which promises a better coupling to aqueous environments and thus a better cutting behaviour. The laser of 810 nm shows



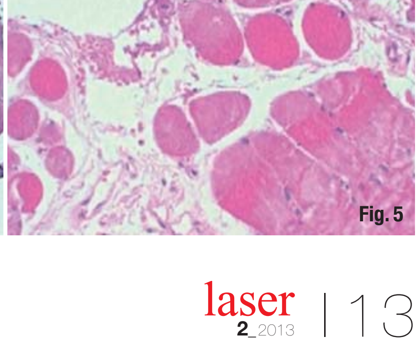


Fig. 4_Histology of tongue specimen, radio frequency (2.2 MHz).

Fig. 5_Histology of tongue specimen, diode laser (980 nm).

Fig. 6_LaserHF – Combination of diode laser and radio frequency.

a lower water absorption and a higher absorption haemoglobin, which promises a good coagulation. The differences, however, are actually rather low. And there is a historical explanation: Laser diodes with 810 nm were introduced to the market long before laser diodes with 980 nm. In addition, 980 nm laser diodes are now mainly used for many industrial applications.

High laser power and shorter pulse durations are propagated by the providers. The pulsed application, in fact, has advantages, especially if very short pulses of a few µs are used. The thermal influence is significantly lower. However, it also means that the already low working speed is further reduced. Moreover, with any increase of laser power, the risk of damage to adjacent healthy tissue may become greater than the desired therapeutic effect.

The advantage of the laser, however, can be seen particularly in superficial applications, for example for killing of bacteria in periodontic and endodontic applications, to expose overgrown implants or for trimming the gingiva. The use of photodynamic therapy, in laser therapy (soft laser) and tooth bleaching, are additional and can be attained only with lasers. In oral surgical applications, such as the removal of fibroma and haemangioma and performing frenectomy and in larger invasive applications, the radio frequency provides clear advantages because of a faster and more precise interaction.

Using very thin, flexible electrodes made of special metal alloys, the electro-magnetic waves are passed into the tissue. This approach allows fast, precise, pressure-free and nearly athermal cutting. In addition, bleeding is controlled effectively by the adjustable coagulation.

Compared to laser, radio frequency provides—because of the rigid metal electrodes, which are available in various forms for specific indications—a better tactile feeling than does glass fiber. This results from the predetermined length of the electrode as well an exact depth of penetration. The high speed is advantageous for larger and deeper cuts.

Requests for higher laser output power or for constructing appropriate pulse technology will affect the price of the devices, which will become more expensive. Additional costs of the supplies, especially the often in surgical operations at high power damaged glass fibers must be considered as a considerable part.

For hygienic points of view and also taking into account the necessary quality assurance system in a dental practice, the consideration is to use sterile fiber tips instead of repeatedly preparing laser fibres.

The radio frequency technology, however, can be realized relatively inexpensively in the device design. Compared to optical fibres, the metal electrodes can be prepared relatively simply and sterilised many times.

Figure 6 shows the combination device LaserHF (Hager & Werken, Germany). It consists of a 975 nm laser with a power of 6 W, combined with a 2.2 MHz radio frequency generator with a power of 50 W and with a 660 nm laser with a power of 100 mW as a therapy supplement for photodynamic and low level laser therapy.

_Conclusion

With regard to its potential applications, the combination of a diode laser with a radio frequency device meets the desire for a perfect system for complete soft tissue management._

_contact laser

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