Multi-clinical Applications of Er:YAG Laser in Oral and Maxillofacial Surgery

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Abstract
Introduction: Laser application in dentistry is the latest innovative modality which has been used in different dental and surgical fields. Among the different types of lasers, the Er:YAG laser is used for soft tissue surgery in numerous ways.

Methods: Forty five patients, who had various oral conditions, were referred to the Department of Oral and Maxillofacial Surgery in Alwasity teaching hospital and selected to be treated by Er:YAG Laser. The subjects were divided into six groups based on the clinical diagnosis. Group1 for 17 subjects with polyps, Group2 for 6 subjects requiring implant exposure, Group3 for 16 subjects requiring frenectomy, Group4 for 1 apicectomy, Group5 for 2 subjects with aphthous ulceration and Group6 for 3 subjects with pyogenic granuloma.

Results: Our study confirmed that soft and hard tissue surgery by Er: YAG laser had less oedema, post-operative bleeding and pain, good cutting and coagulation effects, easily tolerated and rapid uncomplicated healing processes in comparison to the conventional surgical methods of treatment.

Conclusion: With laser surgery, treatment times and post-operative healing periods are much shorter. Using Er: YAG lasers in soft-tissue surgery means that sutures are rarely needed, and with the laser’s simultaneous disinfection effects, healing is faster with fewer post-operative complications.

Introduction
Dentistry has a new weapon in the fight against tooth decay. This “lightsaber” of dentistry is the Erbium laser. The dental laser is the latest in modern innovations for the 21st Century. The Erbium laser has proven to be safe and effective for the removal of tooth decay and cavity preparation, in addition to many soft tissue and hard tissue surgical procedures. The FDA approved the Erbium laser for marketing in the United States as of 1997 (Nash 2002).

Er:YAG lasers are solid-state lasers whose erbium-doped yttrium aluminium garnet (Er:Y3Al5O12) is the lasing medium. Er:YAG lasers classically emit light with a wavelength of 2940 nm, which is infrared. If compared with Nd:YAG or Er:Glass, Er:YAG laser is intensely absorbed by water which is considered to limit its use in surgical procedures or any other applications where water is present. Er:YAG lasers have been used for laser resurfacing, which includes treating acne scarring, deep rhytides, and melasma. In addition to water, Er:YAG laser energy is also absorbed by hydroxyapatite, which makes it a very good laser for cutting bone as well as tissue. Many studies have described the use of Er:YAG in different oral and maxillofacial surgical procedures (Bornstein 2004, Stubinger et al. 2008, Schwarz et al. 2007).

Er:YAG was also applied in the treatment of different oral conditions. Pyogenic granuloma is one of the laser treated conditions. It is a common tumour-like growth of the oral cavity which is unrelated to infection and represents an exuberant tissue response to local irritation or trauma. Clinically, it is a smooth or lobulated mass that is usually pedunculated and some lesions are sessile. The surface is characteristically ulcerated and ranges from pink to red to purple depending on the age of the lesion (Epivatianos et al. 2005, Bhaskar & Jacoway 1966).

Key words: Er:YAG, laser therapy, oral and maxillofacial surgery, Kavo laser machine, dental.
procedures (Seward et al. 1987). Er:YAG laser is further useful in apicectomy procedures for performing an osteotomy and root resection (Gouw-Soares et al. 2001). An aphthous ulcer, also known as a canker sore, is a type of oral ulcer, which presents as a painful open sore inside the mouth or upper throat and is characterized by a break in the mucous membrane. Its cause is unknown, but it is not contagious. The condition is also known as aphthous stomatitis, and alternatively as Sutton’s Disease, especially in the case of major, multiple, or recurring ulcers (Neville and Allen 2009). The aim of the study is to evaluate the effect of Er:YAG laser in different surgical procedures.

Materials and Methods

Forty-five subjects from the Department of Maxillofacial Surgery at Alwasity Teaching Hospital were selected for this study. All the recruited subjects required laser therapy to address different oral conditions. The subjects were divided into six groups based on the clinical diagnosis (Table 1).

Written consent forms were signed by the subjects prior to the laser treatment. The treatment was conducted by the same surgeon. The laser machine used in this study is Kavo K.E.Y laser 3, 1243. Its technical data is the following, as shown in the catalogue:

Therapy laser
Laser type Solid-state Er:YAG laser
Laser class 4
Wave length 2.94µm (infrared)

Pulse energy at exit of laser contra-angle hand piece 2060 10-600
Adjustable in the range
10-200mJ in 20 mJ steps
200-600mJ in 50 mJ steps
Pulse frequency 1-25 Hz

Pilot laser
Laser type Red laser diode
Laser class 2/max. 1mW
Wave length 655nm red
At the time of operation, we gave general anaesthesia for some patients, local anaesthesia for others, and the remaining patients were given topical anaesthesia. With regards to laser, we provided particular energy and frequency for each patient, as will be shown in the results section.

Results
After the selection and diagnosis of the cases by the maxillofacial surgeon, 45 cases were operated on by Er:YAG laser. Depending on the diagnosis, we operated on the following cases with different management, as shown in Table 1. These cases were:

1-Fibroepithelial polyps: (Fig. 1)

The number of cases was 17, six of them were male while the females were eleven (Mean age = 42). The cases were operated on either with local anaesthetic infiltration or topical anaesthesia. There was no need for suturing.

A. Fibro-epithelial polyp on the dorsum of the tongue
B. The same patient shown in Figure 1.a, after polyp excision by Er:YAG laser

Figure 1.a

Figure 1.b
2-Implant exposure: (Fig. 2)
The number of subjects was 6, four patients were males and two of them were females (Mean age = 31 years). 4 cases were operated on topical anaesthesia, while for the other two cases local anaesthetic infiltration were used. No sutures were performed.

3-Frenectomy: (Fig. 3)
The number of subjects was 16. This was divided into:

- a-Labial fraenum
- b-Lingual fraenum (tongue tie).

a-Labial fraenum: 4 subjects, one of them was female and the others were males (Mean age =10 years).

b-Lingual fraenum(tongue tie): 12 subjects, eight patients were males while females were four (Mean age = 9 months).

Either general anaesthesia or local anaesthetic infiltration was required in these cases. In most of the cases no sutures were performed.
4-Apicectomy
Only one male (thirty-two years old) was recruited. Local anaesthetic infiltration was used in this operation which ended with suturing of muco-periosteal flap.

5-Aphthous ulcer
Two females were diagnosed with Aphthous ulceration (Mean age 17 years). Subjects were treated with topical anaesthesia, there was no need for suturing in both cases.

6-Pyogenic granuloma: (Fig. 4)
The number of cases was 3. Two patients were females and other was male (Mean age 35 years). The excisions were done under local anaesthesia and sutures were performed.

The results of our study confirmed that soft tissue surgery by Er: YAG laser had less oedema, post-operative bleeding and pain, good cutting and coagulation effects on soft tissues in comparison to the conventional surgical methods of treatment such as scalpel and electrocautery. The procedure was easily tolerated and postoperative pain was low or absent.

Regarding dental and bone surgery (group 4), Among all other lasers, Er: YAG laser can be used in almost all steps of peri apical surgery: incision for flap, bone removal, removal of granulation tissues, apex resection and retrograde cavity because of its efficacy in soft tissue, bone and dental tissues removal. Er: YAG lasers are appropriate for the treatment of hard tissues without inducing discomfort, vibration or noise. Furthermore, risk of surgical field contamination and damage to the surrounding tissues is decreased when compared to the surgical drilling technique.

As result of that we ended with rapid uncomplicated healing processes in the majority of cases when compared to conventional surgical methods.

**Figure 4.a**

**Figure 4.b**

A. Pyogenic granuloma in the lower anterior edentulous ridge
B. Healing after 8 days from the complete excision for the same lesion shown in Figure 4.a by Er:YAG laser
Discussion
The therapeutic effect of Er:YAG laser is based on the photothermal interaction, where the biological effect of K.E.Y laser is not only thermal, but also mechanical and best described as a thermo-mechanical effect (Niernz 1996). The absorption spectrum of water shows that the wavelength of the K.E.Y laser of 2940 nm coincides with maximum absorption in water (Catone and JR 1997). During the surgical operations of all the cases considered in this study, no significant bleeding was noticed and that is because the K.E.Y laser seals the small blood vessels (Strauss 2000). For example, when we excised polyps, we found no bleeding at all because the clotting due to the laser application acts as a seal on the excised tissue, and for that reason no suture was performed.

With regards to pain, the laser lessens the pain threshold to an extent because the laser seals the nerve endings (Mancuso 1991). In some cases, for example polyps, implant exposure, aphthous ulcer and pyogenic granuloma, we did not use local anaesthetic infiltration in this research work, but if we did not apply the laser in these cases we had to inject local anaesthesia. This is one of the advantages of laser compared with the scalpel and by this we protect the patient from the side effects of local anaesthesia (Keon 1992).

We agreed with some authors who suggested that mild oedema was seen in the first few days after laser application before gradual shrinkage in this oedema and swelling (Rechmann et al. 1998). The oedema-reducing effects of the low-power laser results from increased micro vascularization (Rozenborn & Fiszerman 1995, Rozenborn 1995), accelerated lymphatic flow (Pontinen & Airaksinen 1989, Pontinen 1998), and enhanced tissue oxygen uptake. The number of nail bed and mesenteric capillaries increases after laser stimulation. Laser irradiation enhances blood flow to oedematous, ischemic or hypoxic tissues in general. The most marked increase in capillary density laser irradiation occurs at the dermal-epidermal junctions.

Conclusion
The conclusion drawn from this study is; the Er:YAG laser is a good tool to use in oral surgery because of its advantages during operations and post-operatively. With laser surgery, treatment times and post-operative healing periods are much shorter. Using Er:YAG lasers in soft-tissue surgery means that sutures are rarely needed, and with the laser’s simultaneous disinfection effects, healing is faster with fewer post-operative complications.

References
Bornstein E (2004). Proper use of Er:YAG lasers and contact sapphire tips when cutting teeth and bone: scientific principles and clinical application. Dentistry today, 23(8), pp.84, 86–9; quiz 89.


