HEALING OF Nd:YAG LASER INCISION IN TONGUE OF RABBITS COMPARED WITH SCALPEL INCISION, AN EXPERIMENTAL STUDY

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ABSTRACT

Background

The incision quality and healing postoperatively are the main goals for the surgeon. Many different laser wavelengths have been used in the field of oral and maxillofacial surgery with many advantages, especially because of their high properties (like selective physical properties, the wave length works in a deeper skin structure and it can be applied for removal of vascular lesion).

Objective

The aim of this study was to compare wound healing in the tongue of rabbits grossly and histologically, after a surgical procedure with Nd:YAG laser and scalpel.

Methods

Twelve healthy local breed Rabbits were used in this study; their average age was (2-6) months, divided in to 3 groups, each group includes 4 rabbits. Two parallel incisions using Nd:YAG laser and a scalpel were performed in the tongue of each rabbit. Power level of 3 Watts was used for the laser incisions. Biopsies were taken from group I after 3 days, group II after 5 days and group III after 7 days.

Results

Grossly, it was found that wound closure (healing) occurred in all of the wounds in scalpel incisions, while it did not occur in Nd:YAG laser incision at 3 and 5days, but seen at 7 days post operatively. Histologically, it was found that wound closure (healing) occurred in all of the wounds in scalpel incisions, while it did not occur in Nd:YAG laser incision at 3, 5 and 7 days post operatively.

Conclusion

When compared with traditional surgical procedure, several valuable characteristics of Nd:YAG laser were found; laser produced precise surgical incisions that did not require suture, with little bleeding tendency which simplified the surgical phase. The disadvantage of laser systems is represented by histologically evident thermal destruction around the laser beam incision and thermal damage caused delayed healing process. Healing of the scalpel incision was faster than Nd:YAG laser incision because scalpel wounds did not cause any thermal damage to the incised tissues.

Keywords: *Healing, Nd: YAG laser incision, Tongue of rabbit, Scalpel incision.*

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INTRODUCTION

The word laser is an acronym for Light Amplification by Stimulated Emission of Radiation, although common usage today is to use the word as a noun (laser) rather than as an acronym (LASER). Many different laser wavelengths have been used in the field of surgery with many advantages.

The Nd:YAG, argon, dye, CO_2 laser, Ho:YAG, Er-YAG and diodes laser scan be used in the field of surgery effectively. Because of the selective physical properties the Nd:YAG, the dye and Argon lasers can be applied especially in the removal of vascular lesions [1-3]. The Ho:YAG laser is the main surgical tool for the TMJ surgery [4] and the Er:YAG laser for the hard tissue removal [5].

Using a laser as a surgical tool allows the surgeon to operate on tissues more precisely and to ablate tissues in areas where access is limited. In bone-cutting, it is possible to use a laser to make some desired shapes and to minimize the mechanical damage in the surrounding tissues [6]. Development of a laser technique for bone surgery offers an attractive alternative [7]. Previously-published studies of lasers and bone cutting have largely focused on the use of the CO_2 laser to perform osteotomies. However, compared with conventional mechanical methods, CO_2 laser osteotomies were demonstrated to induce a significant delay in the healing process, which was attributed to the thermal necrosis or the carbonization generated adjacent to the irradiated area, and the foreign body reactions to charred material [8-10].

Both Nd: and Er:YAG lasers are used for facial skin care and resurfacing. The Nd:YAG laser wavelength works in the deeper skin structure while the Er:YAG laser wavelength is absorbed into the superficial layer of the skin. One reason that accounts for why the Nd:YAG laser has decreased healing time is because its absorbed 16 times more efficiently by water in the cells than the CO_2 laser [11].

Malignant transformation of premalignancies such as oral leukoplakia and oral lichen planus occurs in up to 4% of these lesions [12]. Consequently, due to the malignant transformation early treatment of premalignant lesions is better to be done. Even though there are some reports in the literature on laser assisted tumor treatment, surgery is mostly performed conventionally. As an alternative to the scalpel, the CO_2 laser with continuous wave is an established device which has been in use for more than 20 years.

Advances in laser technology over the past 20 years have led to progress in the treatment of many dermatologic concerns, including scar revision. The argon laser was the first laser used in the treatment of hypertrophic scars and keloids. The CO_2, argon, and (Nd:YAG) have been used for various cutaneous pathologies. The choice of laser for scar revision should be on the basis of the absorption characteristics of the target and the history of the scar [13, 14].

MATERIALS AND METHODS

This study was done between the period 1st January 2007-30th June 2007 in the university of Sulaimani. Twelve healthy local breed rabbits were used in this study. Their average age was 2-6 months and the mean weight was 1.5 Kg, divided in to 3 groups, each group including 4 rabbits. All the animals were weighted to calculate the dose of anesthesia and the antibiotic which would be given to them for prophylaxis. The rabbits were kept in a special cage; they kept indoor during the night and were exposed to sun light during the day. All the animals were raised under the same circumstances. They were fed on wheat, green vegetables and bread. Their places in the cage were cleaned every day to keep the animals healthy and disease free during the experimental work.

The procedure was done under general anesthesia (Ketamine injection, 35mg/kg body weight intramuscularly). After the anesthesia has been achieved; each rabbit was positioned with opened jaws and protruded tongue. Chlorhexidine 0.2% was use at the site of incision.

Two incisions of mucosa were made (about 8-10 mm length and 2 to 2.5 mm depth) on each side of the dorsal surface of the tongue and left without suturing; one incision was made by blade no.15 on the right side and another one by laser on the left side. Sterile normal saline solution 0.9% w/v was manipulated during use laser for cooling. Recording the surgical notes (time, size of incisions, bleeding) post operatively. All incisions were made on the anterior 2/3 of the dorsum of the tongues. All laser incisions made on the left side of the tongues while all blade incisions were made on the right side of the tongues. The length of the incisions was about 8 to 10 mm, while the depth was 2 to 2.5 mm. Then clinical observation

of the wound was followed up. Scarifications of the rabbits: by giving overdose of Ketamine with Xyline injection. Group I was scarified after 3days of incisions, group II after 5days, and group III after 7days of incisions. Taking two biopsies from the tongue of each rabbit at the site of incision and saving them for few hours in a small bottle containing 10% Formalin, then sending them for slide preparation and histopathological examination.

RESULTS

Gross appearance

According to the macroscopical findings, wound closure occurred in all of scalpel incisions at 3, 5, and 7 days of healing, while wound closure did not occur in Nd: YAG laser incision at 3 and 5 days, it occurred on 7th day after Nd:YAG incision.

Histological appearance

After blade incision, at the 3, 5 and 7 days, microscopically examination showed healing of the connective tissues and stratified squamous epithelium; chronic inflammatory cells were seen in the site of incision.

After Nd:YAG laser incision, at the 3, 5 and 7 days microscopically examination showed no evidence of healing of the connective tissues or stratified squamous epithelium. Few numbers of chronic inflammatory cells were seen in the site of incision.

Table 1. Gross appearance of the incisions healing of the tongue.

Type of incision	Day 3	Day 5	Day 7
Blade incision	Closed	Closed	Closed
Laser incision	No closure	No closure	Closed

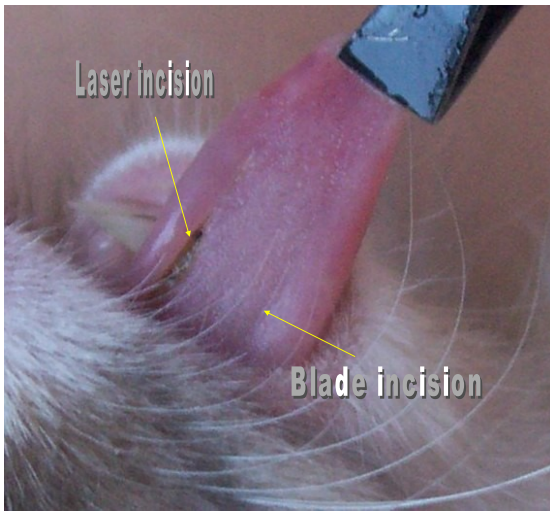

Figure 1. Three days after blade and Nd:YAG laser incision.

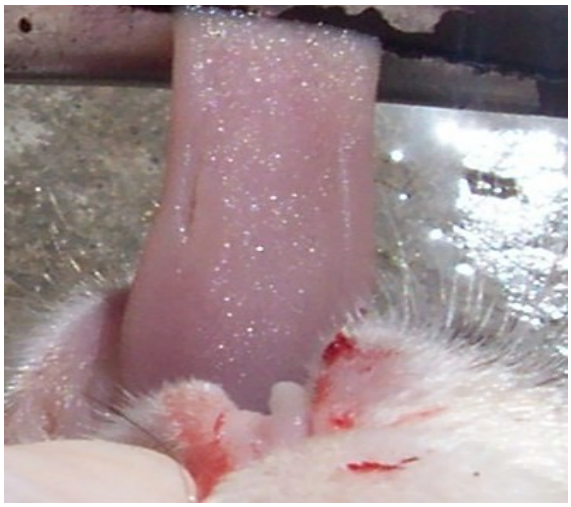

Figure 2. Seven days after blade and Nd:YAG laser incision.

Table 2. Histological appearance of healing of epithelium and connective tissue by using both scalpel incision and laser.

Type of incision	Day 3	Day 5	Day 7
Blade incision	Healing and chronic inflammatory cells	Healing and large No. of chronic inflammatory cells	Healing and few No. of chronic inflammatory cells
Laser incision	No healing and chronic inflammatory cells	No healing and large No. of chronic inflammatory cells	No healing and large No. of chronic inflammatory cells

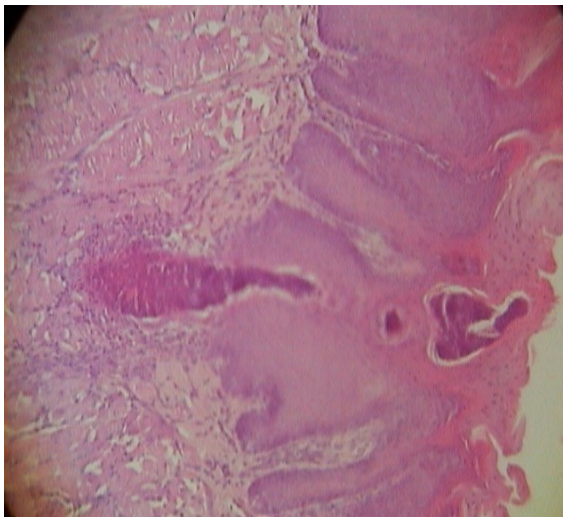

Figure 3. Mucosa of the tongue, three days after blade incision.

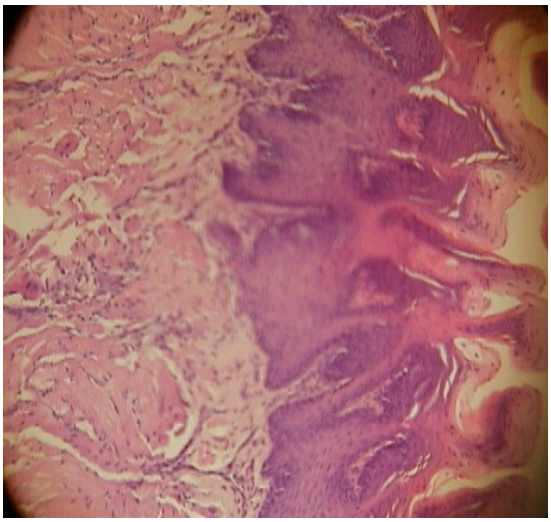

Figure 4. Three days after Nd: YAG laser incision.

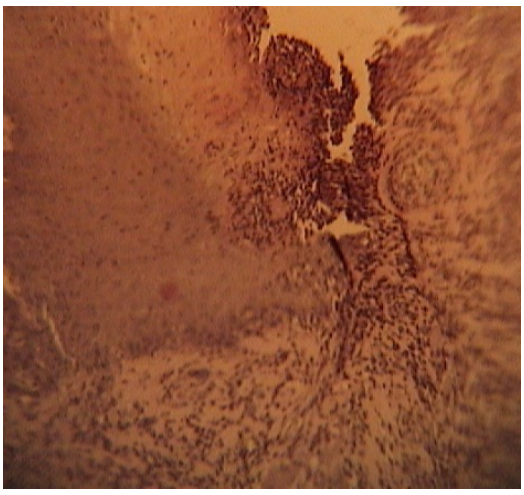

Figure 5. Mucosa of the tongue, seven days after blade incision.

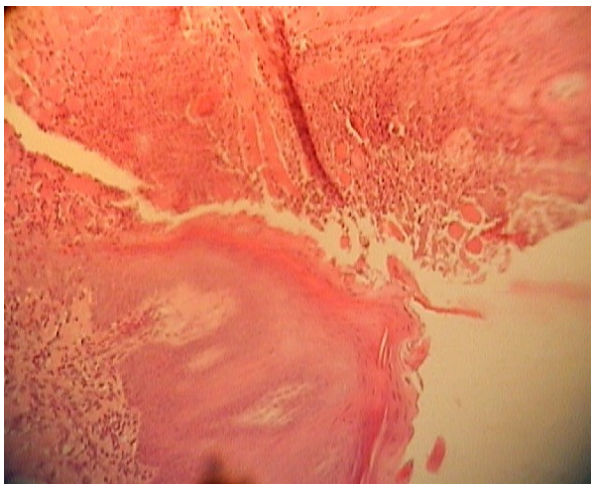

Figure 6. Seven days after Nd:YAG laser incision. Absence of union (healing) in the incision area.

DISCUSSION

In minor oral surgical procedures, Nd:YAG laser therapy certainly is more invasive and presents some advantages such as the elimination of bleeding and suturing as well as minimal post surgical pain and edema [14].

During the present study the differences in healing between surgical wounds produced by scalpel and Nd:YAG laser were compared. The disadvantage of Nd:YAG laser is represented by histologically evident thermal destruction around the laser beam incision and thermal damage, This is agreement with the studies done by Mester and Pogrel [15,16].

Wavelength of the laser, power setting (watts), continuous/pulsed mode, pulse duration, pulse frequency, and exposure time are important laser parameters affecting the extent of thermal injury to the tissues. Scalpel wounds, in contrast, do not cause any thermal damage but allow extravasations of blood and lymph, causing a more marked inflammatory response with resultant swelling and formation of a scab [14].

A histological analysis of the epithelium and connective tissue of the tongue was performed, and inflammatory cells and vasodilatation were also evaluated. The healing process after the laser technique is shown to be worse when compared to scalpel wounds of 3, 5 and 7 days.

Healing parameters in laser incision were low when the tissues were radiated with Nd:YAG laser. An excessive absorption of energy can induce thermal damage with necrosis and tissue carbonization. The action of laser at lower power output instead reduces the effectiveness of the incision, but also minimizes thermal damage of the tissue [17, 18].

In fact, since different thermal effects are produced in biological tissues exposed to radiation, the right type of laser settings should be carefully chosen, depending on the clinical demands and the different tissue characteristics. In such a way, it would be possible to guarantee the maximum clinical effectiveness, avoiding damage to the radiated tissue [19].

Since Nd:YAG lasers are absorbed by dark substances such as hemoglobin, their in-depth propagation into tissue is related to the wavelength employed and the coefficient of absorption of the same tissue have shown that the healing mechanism depends on laser parameters the best healing results were observed at an output of 4 watt. Our histological analyses showed the healing of Nd:YAG laser incision is very slow because we used 3Watt [20].

The wound healing of soft oral tissues after diode laser irradiation and concluded that the clinical application in oral surgical procedures seems to have a beneficial effect, this is in disagreement with our study because there was destruction of the tissues after exposure to Nd:YAG laser. Also these and our results are disagreeing with findings done by Goharkhay *et al.* which revealed that diode laser therapy did not accelerate the healing of oral mucosa after gingivoplasty [21].

In our study epithelial regeneration after Nd:YAG laser incision is very slow when compared with conventional surgical wounds. This is in account with the study done by Fisher which found that laser wounds after CO_2 laser irradiation of the oral mucosa tend to show less collagen formation, little wound contraction, and slower epithelial regeneration compared with conventional surgical wounds [22].

Possible explanations for the delayed re-epithelialization of laser wounds include inhibitory substances produced by necrotic tissues, physical hindrance caused by the presence of eschar, or heat fixation of adjacent epithelial cells [23].

Based on the aforementioned considerations, the objective of this study was to compare the efficacy of Nd:YAG laser with scalpel surgical procedure was evaluated at the different post surgical time points of the Nd:YAG laser wounds and the scalpel wounds. Evaluation of the inflammatory response in this study demonstrated that Nd:YAG laser wounds (especially 7 days after irradiation) tend to be associated with more inflammatory cells when compared with scalpel wounds.

To eliminate the unwanted thermal damage and consequent loss of substance, the surgical incision was performed in this study by slow but continuous movements of the optic fiber along the area to be treated to eliminate the loss of substance and favored the mechanism of healing.

In conclusion, traditional surgical procedures allow an incision without loss of tissue. Result of the present study showed that Nd:YAG laser tends to produce more pronounced changes (due to tissue thermal damage) than conventional surgical procedures with corresponding greater inflammatory reaction and delay in tissue organization.

From this study, it was also found that attention to choosing suitable parameters and opportune clinical use of laser equipment allowed optimization of incisions and good clinical follow-up procedure resulted in a control of bleeding; a drastic reduction of the loss of tissue.

All the advantages offered by laser surgical procedures are certainly magnified in patients with hemorrhagic diathesis, which requires strict control of bleeding.

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