Diode type laser in resection biopsies of superficial benign lesions of oral mucosa: a histological analysis

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Abstract

Aim: The aim of this study is to assess whether the thermal damage caused by the diode laser during the excision of benign lesions of the oral mucosa affects the histopathological diagnosis or the safe evaluation of fibroepithelial lesions' excision margins. In addition, a comparison of the surgical margins' histological appearance between benign fibroepithelial lesions of the oral mucosa subsequent to diode laser treatment and traditional surgery is attempted.

Materials and Methods: Out of 60 cases, 30 were treated surgically and 30 with diode laser. All lesions were benign and excised on clear margins using either method (surgical or laser). The removed specimens were examined using a light microscope aided by an image analysis method, while the thickness of thermal necrosis zone was also measured.

Results: This analysis concluded that the thickness of the thermal necrosis zone, measured by the image analysis method in our material, is directly proportional to the type and the dimensions of the lesion, suggesting that the laser method of excision is an alternative method potentially characterised by selectivity and accuracy, with regard to the removal of tissue lesions. Laser penetration depth during the resection of the lesions can be controlled. The hemostatic property of laser was apparent as well as the reduction of fibrous connective tissue, leading to faster recovery.

Conclusion: Image analysis method illustrated that the thickness of the thermal necrosis zone permits clear histological margins that guarantee the clean and complete excision of lesions. Based on the above, expanding the use of laser in the excision of malignant lesions of the oral cavity should definitely be considered.

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Introduction

Although, in dentistry, laser has been used in conservative therapeutic treatment of oral disorders such as periodontitis and peri-implantitis, its use in oral surgery still remains in a primary stage [1-4].

Over the past few years, a large number of clinical, laboratory and research data has been collected on the application of different wavelength laser techniques in the excision of benign lesions of the oral cavity [5-9]. The use of laser in surgical treatment offers advantages to both surgeons and patients. The rapid and accurate handling of surgical techniques improves therapeutic remedial restoration and alleviation of post-operative symptoms (such as pain, edema, hyperemia) [10-11].

The most common lesions of the oral cavity (benign tumors, chronic papillary inflammatory processes, cysts, etc.) are structured by the covering multi-layered squamous epithelium and the underlying subepithelial connective tissue of the oral mucosa, and resemble similar lesions to other anatomic locations.

Hyperplastic fibroepithelial lesions are the most frequent tumor-like processes associated with chronic injuries (buccal, lip and tongue biting). They are painless masses of fibrous connective tissue, which are stable for years, while they are covered by smooth and pinkish mucosa without ulceration [12]. The histological features of benign lesions consist of hyperplastic squamous epithelium, often in the form of pseudo-epitheliomatous hyperplasia, while the subepithelial connective tissue is generally cellular, composed of widely dispersed mature fibroblasts. Chronic perivascular inflammatory infiltrate is commonly identified, especially when the concurrent presence of Candida albicans superinfection is appreciated, or the existence of precancerous dysplastic epithelial changes is observed. The diode laser has been reported extensively as contributing significantly to the treatment of benign vascular and precancerous lesions of the oral mucosa [13-16].

The accuracy and clarity of pathological diagnosis and the extent of thermal damage due to laser are contradictory points for the widespread use of the surgical laser method. Nonetheless, careful invasive manipulations are expected to significantly reduce the thermal damage of the laser and improve the process of tissue healing [17-19].

The purpose of this study is to assess whether the thermal damage caused by the diode laser affects the histopathological diagnosis or the evaluation of benign lesions' excision margins. In addition, a comparison between the histological appearance of benign fibroepithelial lesions of the oral mucosa after surgery with laser and conventional surgical treatment is attempted.

Materials and Methods

Our sample consisted of 60 cases of benign lesions of the oral cavity mucosa.

A 984nm diode type laser was used in half of the cases. Out of 60 respective patients, 41 were women aged 14 to 82 years old and 19 were men aged 10 to 63 years old.

The material consisted of cases that corresponded in order of frequency to reactive fibroma (29 cases), inflammatory papillary hyperplasia (9 cases), papilloma (6 cases), epulis (3 cases), leukoplakia (3 cases), mucus cysts (3 cases), pyogenic granulomas (2 cases), angiokeratomas (2 cases), epidermal cysts (2 cases) and fibroepithelial polyp (1 case).

The size of the lesions ranged from 3 mm to 15 mm. The most common locations the lesions were gingiva, tongue, and mucous membrane of lips, cheeks, tongue, and hard palate.

A diode laser type with a wavelength of 980 nm, a penetration depth of 3-5 mm and energy of 2-3 watt was chosen for laser treatment. A pulse wave was used in order to avoid thermal damage. Out of 60 cases in total, 30 were treated surgically and 30 with diode laser.

More specifically, 15 reactive fibromas, 5 inflammatory papillary hyperplasias, 3 papillomas, 2 leukoplakias, 2 mucus cysts, 2 epulis and 1 angiokeratoma were treated with laser, whereas 14 cases of traumatic fibroma, 4 cases of inflammatory papillary process, 3 cases of papilloma, 2 cases of pyogenic granuloma, 2 cases of epidermal cyst, 1 case of epulis, 1 case of leukoplakia, 1 case of mucous cyst, 1 case of angiokeratoma and 1 case of fibroepithelial polyp were removed surgically (Fig. 1).

Figure 1. *Fibriepithelial polyp of buccal mucosa: a. preoperatively, b. after laser excision*

In most cases, only local anesthesia was administered using a cotton dipped in lidocaine. The patients were re-examined 3 days, 1 week and 3 weeks after the intervention.

Following the excision, the tissue was fixed in 10% neutral formalin solution for 2 days and embedded in paraffin. Using a microtome, 3mm thick histological sections were taken and stained with the Eosin-Hematoxylin method. Microscopic evaluation was performed under a light microscope using image analysis. The thickness of the thermal necrosis zone was measured on the lesions removed with diode laser and the thickness of the healthy tissue which was excised with the scalpel in the cases conventionally treated.

Results

Microscopically, all lesions were nonmalignant and removed on healthy margins regardless of the applied method (conventional surgery or laser).

In surgically excised tissues, the thickness of healthy tissue excised peripherally to the lesion was around 1mm in most cases. However using the laser method, the thermal necrosis zone formed in the lesion's background and adjacent tissues, can offer distinct and clear excision margins (Fig. 2).

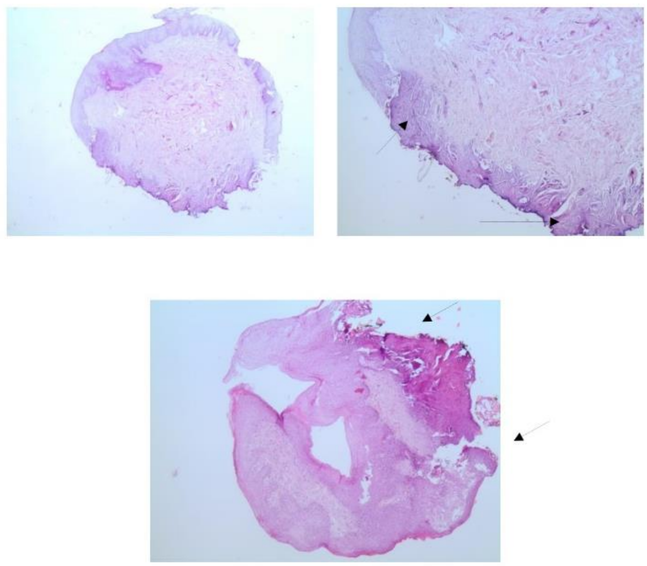

Figure 2*. Histological images of traumatic fibroma (up) and mucocele (down). Note the thermal necrosis zone (arrows)*

The thickness of the thermal necrosis zone, measured by the image analysis method in our material, ranged from 101 to 192 μm. Table 1 shows that this thickness is directly proportional to the type and size of the lesion. Large-diameter lesions with large amount of fibrous connective tissue have a thicker thermal necrosis, whereas small-diameter lesions with less fibrous connective tissue have a thinner one. These findings implicate that laser penetration depth during the resection of the lesions can be controlled when the type and size of the lesions are considered and the parameters of the laser applied per case are controlled, based on the laser method selectivity and accuracy.

In laser excised tissue, a significant reduction in scar tissue and tissue shrinkage was observed, thus leading to faster recovery.

Finally, it is worth noting that in all cases, the hemostatic property of the laser was apparent, giving a visible surgical field. It seems that the thermal necrosis zone caused by the laser, acts as a hemostatic plug.

Discussion

In the studied cases, we observed that laser interacts differently with different type of tissues. This is justified by the different penetration rate of the laser, which depends on the composition and size of the tissue, as well as on the parameters of laser such as wavelength, pulses, Hertz, and Joules. More specifically, different types of tissues absorbed different amounts of laser energy. The oral tissue is occasionally pigmented; melanin, hemoglobin and collagen chromophores, due to the chromophilic property of the diode laser, absorb the laser energy better. In addition, the tan oral mucosa can absorb the laser's energy quickly and thus give the surgeon a quick and precise cut [11-13].

Furthermore, the removal of edematous and hyperemic tissue was clearly more rapid as opposed to relatively healthy tissues. This was due to the high content of the former tissues in dilated capillary vessels and increased amount of interstitial liquid, which facilitated the absorption of laser energy [11-13].

The tissue thickness affected the effectiveness of the diode laser. In thin mucous membranes with a small amount of fibrous connective tissue, such as in mucocele excisions, the laser has been shown to be a particularly effective and fast tool (1-2 watts), as opposed to some traumatic fibrous connective tissues, in which the large amount of connective tissue absorbed the laser energy, and made it necessary to increase it up to 3 watts).

It is a fact that in laser treated specimens tissue clotting is secondary. No bacterial contamination was observed due to the bactericidal property of the laser and the protective layer of fibrin created directly, which give the tissue the possibility of rapid healing.

The non-injecting nature of anesthetic surgery, as well as the precise cutting of the laser, ensured minimal mechanical injury and offered reduced postoperative pain and edema.

It should be pointed out that the laser-induced thermal damage has in no way affected the histopathological diagnostic procedure of the lesions in all cases. The advantages in using the diode laser method include: reduced pain, less visits to the doctor, postoperative progression, non-suture of the wound, hemostasis and avoidance of unnecessary anesthesia. The disadvantages are the risk of thermal damage to the underlying and adjacent tissues in the application area, in case of malpractice, as well as the increased cost [11-13,17]

Comparing the excision of lesions with diode laser and scalpel, we concluded that for intraoral soft tissue surgical techniques, laser is a reasonable alternate to the scalpel [20].

Conclusions

Our analysis, using the application of image analysis method, concluded that the thickness of the thermal necrosis zone permits clear histological margins that guarantee a safe and complete excision of the lesions, while also controlling the penetration degree of the laser during the tissues' cutting. It should be taken into account that similar thermal necrosis thickness is also present in the surgical field of the tissue after the lesion is removed which, ultimately, extends the clear margins of excision.

Based on the above, expanding the use of laser in the excision of malignant lesions of the oral cavity should definitely be considered. In oral mucosal lesions such as leukoplakia (focal or multifocal), high-grade epithelial dysplasia, in situ carcinoma and microinvasive carcinoma, the use of the laser can provide positive results. This was also evident in the cases of leukoplakia of our material. Moreover, laser surgery has already been applied to the excision of dysplastic lesions, in situ carcinomas and microinvasive carcinomas of the breast, urinary bladder and gastroesophageal junction.

It should be emphasized that both methods (laser and conventional surgery) beyond any of the advantages or disadvantages described above, can provide the patient with safe and complete therapeutic effects..

Table 1. Thermal necrosis zone thickness of the excision sites removed with laser, measured with image analysis method

Lesion	Lesion Diameter (mm)	Thermal necrosis zone thickness (μm)
1. Lower lip fibroma	3	121.15
2. Buccal fibroma	4	139.62
3. Hard palate fibroma	14	190.39
4. Buccal fibroma	6	142.13
5. Lower lip fibroma	5	144.48
6. Lower lip fibroma	3.5	121.54
7. Tongue fibroma	6.5	152.25
8. Frenulum	3.5	126.65

9. Tongue fibroma	8	169.22
10. Lower lip fibroma	4	127
11. Tongue fibroma	12	190.44
12. Buccal fibroma	6.5	142.35
13. Buccal fibroma	7	149.24
14. Tongue fibroma	5	139.45
15. Buccal fibroma	15	192
16. Papillary inflammatory gingival hyperplasia	5	106
17. Papillary inflammatory gingival hyperplasia	8	141.22
18. Papillary inflammatory gingival hyperplasia	4	103
19. Papillary inflammatory gingival hyperplasia	5	152
20. Papillary inflammatory gingival hyperplasia	3.5	124
21. Upper lip fibroma	3.5	124.26
22. Lower lip fibroma	4	105
23. Tongue fibroma	3.5	129
24. Lower lip leukoplakia	3	112
25. Lower lip leukoplakia	3	131.77
26. Epulis	6	121.82
27. Epulis	6	139.62
28. Lower lip mucocele	3	136.28
29. Lower lip mucocele	3	102
30. Upper lip angiokeratoma	3	101

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