Review Article

DOI: 10.17354/ijss/2015/371

Lasers in the Management of Oral Pre-Malignant Lesions

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Abstract

Oral premalignant lesions of the oral cavity such as leukoplakia and erythroplakia remain a diagnostic and treatment challenge. They have a potential for malignant transformation. Management of such lesions includes observation, excision, ablation, or topical medical therapies. The gold standard for management of the clinically evident high-grade premalignant disease is excision or laser ablation. Laser treatment has been a well-established modality for management of premalignant lesions and has potential advantages over surgical excision. With the availability of portable and more cost-effective lasers, this technology is now feasible even for outpatient management of such cases. The angiolytic lasers can be used to target the vasculature of oral lesions, leaving intact mucosa, thereby resulting in less discomfort for the patient. Various studies have shown the application of various lasers such as carbon dioxide, thulium, 532 and 940 nm diode, and 532 nm pulsed potassium-titanyl phosphate laser, in the appropriate management of oral premalignant lesions.

Key words: Carbon dioxide laser, Leukoplakia, Premalignant lesion, Potassium-titanyl phosphate laser

INTRODUCTION

More than 500,000 new cases of head and neck squamous cell cancer arise annually worldwide, making it the sixth most common cancer.[1] Of these oral cavity, malignancies account for 14% and lead to upward of 7000 deaths per year.[2] From a genetic perspective, the progression of oral squamous cell carcinoma (SCC) comprises of a distinct pattern and timing of genetic alterations along a continuum of malignant transformation.[3]

Visible oral lesions such as leukoplakia, erythroplakia, oral lichen planus (OLP), and its mixed forms can alert health care providers to a premalignant disease process.[4] Such lesions may harbor histological changes such as squamous hyperplasia, mild dysplasia, moderate dysplasia, severe dysplasia, and carcinoma *in-situ*. Patients with this condition experience a 50-60-fold greater risk of developing oral cancer than the remainder of the population.[5] According to World Health Organization 2005, oral leukoplakia can be defined as "a white plaque of questionable risk having excluded (other) known diseases or disorders that carry no increased risk for cancer."[6] It is the most common premalignant lesion of the oral cavity and is clearly associated with tobacco abuse with alcohol acting as an additive factor. The term erythroplakia (erythroplasia) is used analogously to leukoplakia to designate lesions of the oral mucosa that present as bright red velvety plaques which cannot be characterized clinically or pathologically as due to any other condition. It is associated with a higher risk of malignant transformation. It is found in association with leukoplakia but has less cellularity and keratinization and thus appears redder in color. OLP is yet another white lesion with characteristic reticular appearance. The reported transformation rate of OLP is between 0.5% and 5%.[7] The management of these lesions has always been controversial.

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www.ijss-sn.com

Month of Submission : 06-2015
Month of Peer Review : 07-2015
Month of Acceptance : 07-2015
Month of Publishing : 08-2015

DISCUSSION

Evaluation/Workup

A thorough case history should be taken to identify risk factors for SCC such as tobacco, alcohol, betel nut chewing,

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and HIV status. Since some drugs cause lichenoid changes (for example, non-steroidal anti-inflammatory drugs, sulfonylureas, beta-blockers, angiotensin-converting-enzyme inhibitors, and anti-malarials), gingival hypertrophy (e.g. calcium channel blockers and phenytoin), or mucosal ulceration (e.g. sulfonamides and thiol-containing drugs).

A detailed head and neck examination should be performed to exclude the presence of other lesions. The lesion should be comprehensively examined giving special attention to the homogeneity and nodularity. Ulceroproliferative growth, induration, and irregular borders should raise the possibility of malignancy. Potential local causes such as loose dentures or sharp teeth edges should be evaluated and corrected if present. The patient should be strictly instructed to quit the causative habit such as tobacco abuse, alcoholism, etc. and reevaluated clinically in 4 weeks for a potential biopsy if the lesion does not resolve. If on the first visit no etiologic factor is identifiable, a biopsy should be carried out to stage the lesion and exclude frank invasive SCC. Definitive diagnosis relies on biopsy and histopathological assessment of the specimen.[8]

MANAGEMENT OF ORAL PREMALIGNANT LESIONS

Various treatment modalities have been described for OPLs. They can broadly be divided into surgical and non-surgical treatments. The non-surgical treatments include photodynamic therapy and topical or systemic medical treatment using carotenoids, retinoids, bleomycin, etc.

The gold standard for management of the clinically evident high-grade premalignant disease is excision or laser ablation. However, moderate and low-grade pre-malignancy may be treated with observation as well as ablation.[9]

A wide variety of surgical treatments exist for oral premalignant lesions (OPL). Complete excision and primary closure are performed for smaller lesions. Scalpel excision of larger lesions may negatively impact mechanism of deglutition, speech, and swallowing. High vascularity and unfriendly anatomical locations such as oropharynx, tonsil, a floor of the mouth, tongue, gingiva, buccal mucosa, retromolar area, etc. makes scalpel excision extremely difficult. Also, the resulting open wound may necessitate split thickness skin grafting or dressing using collagen, buccal fat pad, etc. Demetri arnaoutakis and others have opined surgical excision of OPLs is better in preventing their malignant transformation, compared to observation and other non-invasive therapies. Laser excision or ablation of OPLs offers unique advantages over scalpel excision like faster and precise removal of diseased tissue and excellent hemostasis. It has good patient acceptance, low morbidity, and favorable healing.[10]

LASER TREATMENT OF OPLS

The practice of oral and maxillofacial surgery has included the use of lasers since the mid-1960s. Goldman applied laser energy to teeth and soft tissue in 1965. Strong *et al.* used the carbon dioxide (CO_2) laser in the early 1970s for a variety of surgical procedures including the excision of malignant and premalignant lesions. Hemophilic patients benefited significantly from Ackermann's use of the neodymium:Yttrium-aluminium-garnet (Nd-YAG) laser for a variety of oral surgical conditions.[11]

The laser of different wavelengths are applied in oral and maxillofacial surgery (OMFS). Depending on the laser's characteristics, one can select the type of laser most applicable under the given circumstances. With the availability of portable and more cost-effective lasers, outpatient office-based laser treatment is evolving as the therapy of choice for OPLs. The lasers commonly used are classified into visible and non-visible (infrared) wavelengths.[12]

Water Avid Infrared Lasers

The CO_2 laser produces coherent laser energy at the 10,600 nm wavelength in the infrared spectrum and does not have a particular preferred chromophore of absorption. It shows good absorption by water – both intracellular and extracellular. It creates rapid heating of target tissues, causing cells to explode, creating a zone of tissue vaporization, and a surrounding zone of thermal damage, which theoretically seals lymphatics and blood vessels. When used in the focused mode it acts as an excisional instrument ensuring precise surgical margin with minimal char. This also helps in the accurate assessment of surgical margins. Furthermore, it can be used for surface ablation in defocused mode. The CO_2 laser has historically been the workhorse in OMFS laser surgeries. In the past years, the use of the laser has been limited owing to its high cost, bulk, and difficulty in using in poorly accessible areas. However, technological advancements have up to an extent successfully overcome these limitations. The introduction of scanning CO_2 laser may offer potential benefits due to the ability to control precisely the depth of vaporization thereby extending its use to the treatment of large area OPLs.[13]

The RevolixJr (Lisa Laser USA, Pleasanton, CA) is a 15-W thulium-based diode pumped solid-state laser. It produces continuous energy in the infrared spectrum at the 2013 nm wavelength. It has comparable tissue characteristics to the CO_2 laser, due to water being the common chromophore. It has a fiber delivery system which makes it superior and

also allows easier access to restricted areas. It has better hemostatic properties compared to the CO_2 laser, probably due to a larger thermal damage zone, which helps with sealing of vessels. While these characteristics are limiting factors in surgeries on delicate tissues like glottis, the instrument is excellent for use in highly vascular tissues such as the tongue. The thulium laser has mainly been used as an excisional instrument, and its small size allows for easy transportation between the office and the operating room.[14]

Other lasers in this range include Nd:YAG, Holmium:YAG, and Erbium:YAG, which are based on yttrium aluminum garnet crystals doped with either neodymium, holmium or erbium. The Nd:YAG was developed in 1973 and emits light of 1064 nm wavelength. Its penetration power is much deeper than the other lasers described and has a thermal damage area well beyond the depth of normal epithelium. These lasers are not routinely used for treating OPLs.[15]

Hemoglobin Avid Lasers

A more recent development in OMFS has been the introduction of hemoglobin avid lasers. The chromophore for these lasers is hemoglobin, and thus they exert effect specifically upon the vasculature.[16]

The oxygenated and deoxygenated hemoglobin have a relative optical absorption peak between 520 and 550 nm and lower absorption peaks at 750 nm and 940 nm.

The Aura XP and the Varilite are examples for lasers of this type. They are both potassium-titanyl phosphate (KTP) lasers, yielding visible green light at 532 nm. It is produced by passing a Nd: YAG laser beam (1064 nm) through a KTP crystal, thus halving its wavelength to 532 nm.[17] Its usefulness in OPLs lies in its ability to ablate the underlying vasculature feeding the lesion while preserving a biological dressing of overlying mucosa.[18] At higher energy levels, these lasers can also be used in an ablation setting although the KTP causes more charring when compared with water absorbed lasers, and superficial char may need to be removed manually. Both have fiber based energy delivery system, allowing easy access to all areas of the oral cavity.[19]

VARIOUS METHODS OF MANAGEMENT OF OPLS USING LASER

Surgical Resection without Reconstruction

Surgical resection is performed in the office or the operating room depending on the size of the lesion and access.[20] *En bloc* excisions facilitates complete pathologic evaluation and accurate assessment of margins to exclude invasive disease. However, surgical resection without reconstruction of large defects, especially in the floor of the mouth may cause functional impairment.[21] There is significant pain associated with a large deep healing wound. Furthermore, leukoplakia has a tendency to recur even after excision, either within the surgical field or at the edges of resection.[22] Thus, excision may be too radical in many cases of OPLs. Many techniques are present for surgical excision including various lasers. The CO_2 laser causes minimal charring providing clean surgical margins for accurate assessment. However, its hemostatic ability is poorer than hemoglobin avid lasers; hence, electrocautery is routinely employed as an adjunct.[23]

Vaporization

Vaporization of OPLs involves surface application of laser energy for ablation. This technique is found to be suitable for larger, shallower OPLs and is also especially useful in difficult to access areas. It allows treatment of the lesion while ablating superficially. Prior to vaporization representative biopsies have to be taken as there is no surgical specimen to examine for evidence of deep invasion. Also, the surgical bed created after vaporization will have to heal by secondary intention. Both laser excision and vaporization are better known tools than electrocautery treatment in terms of post-operative pain and wound contracture. However, it has potential demerits such as scarring, tethering, and secondary bleeding as it leaves an exposed wound. Areas where resection is not possible such as gingival leukoplakia and other more extensive lesions benefit from laser vaporization. The CO_2 laser is the management option due to its properties like minimal thermal damage to underlying tissue, least char, and thus allowing the most accurate assessment of depth.[23]

CONCLUSION

White and red lesions of the oral cavity remain a diagnostic and management challenge. Use of the laser for management of oral premalignant lesions has got many advantages over other treatment modalities. Through various studies, it can be inferred that surgical management is the gold standard for oral premalignant lesions and laser can be used successfully even for office-based surgical management. Surgical management with in-office lasers has been varied in its techniques and use of both water-avid (CO_2 laser and thulium laser) and hemoglobin-avid (green light 532 nm and 940 nm) lasers. Depending on the location and nature of the lesion, vaporization, vascular ablation, or surgical resection may be an appropriate treatment.

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How to cite this article: Manjunath KS, Raj A, Talukdar JS, Kundu M, Arun PD, Vijayan S. Lasers in the Management of Oral Pre-Malignant Lesions. Int J Sci Stud 2015;3(5):183-186.

Source of Support: Nil, **Conflict of Interest:** None declared.