

# Effectiveness of Diode Laser and Er, Cr:YSGG Laser in the Treatment of Oral Leukoplakia-A Comparative Study

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## Abstract

**Background:** Soft tissue lasers and certain hard tissue laser have been used in the treatment of oral mucosal lesions. This study was an attempt to compare soft tissue laser and hard tissue laser in treating oral leukoplakia.

**Aim and Objective:** To compare the effectiveness of Diode Laser and Er,Cr: YSGG Laser in treating oral leukoplakia by assessing intraoperative pain and bleeding and postoperative pain on the following seven postoperative days as well as wound healing on the 7th, 14th and 21st post-operative days. The one year assessment of recurrence of the lesion was also analysed.

**Methodology:** The study population included five patients, above the age of 18 years, provisionally diagnosed and histopathologically confirmed as having oral leukoplakia. In each patient part of the lesion was treated with Diode laser and the rest with Er,Cr:YSGG laser. Each patient was assessed individually during both laser procedures for intraoperative pain and bleeding during procedure, for postoperative pain on the following seven post-operative days and for wound healing on the 7th, 14th and 21st day after treatment. Pain was assessed using three different pain rating scales and wound healing using visual method. Recurrence by clinical and histopathological analysis after one year.

**Results:** Using Diode laser caused minimal to no pain, excellent hemostasis and good wound healing with no postoperative complications and Er,Cr:YSGG laser caused minimal discomfort to patient, profuse bleeding during procedure and good healing outcome in treatment of oral leukoplakia. No recurrence was observed after one year.

**Conclusion:** While comparing both the lasers, in this present study it has been concluded that Diode laser (940 nm) is superior to that of Er,Cr:YSGG laser (2780 nm) in treating oral leukoplakia. Er, Cr:YSGG laser can also be considered for treating oral leukoplakia.

**Keywords:** Oral leukoplakia; Diode laser; Er,Cr:YSGG laser; Bleeding; Pain reduction; Healing; Recurrence

## Introduction

WHO (2005) declared that "leukoplakia should be used to recognize white patch of questionable risk having excluded other known diseases or disorders that carry no increased risk for cancer" [1]. Oral leukoplakia is a predominantly white lesion of the oral mucosa that cannot be characterized as any other definable lesion [2]. Many causative agents have been implicated in the etiology of leukoplakia. They include tobacco, alcohol, chronic friction due to sharp tooth, electro galvanic reaction, UV radiation, syphilis and so on [3]. Tobacco use is considered to be the primary cause for occurrence of leukoplakia [4]. There is a dose-response relationship between tobacco usage and prevalence of oral leukoplakia [5]. There seems no well accepted treatment method for removal of oral leukoplakia. Leukoplakia is limited to the epithelium, so selected removal of this part of the mucosa seems to be the best choice of treatment. There are different treatment modalities adopted for leukoplakia once it has occurred. First and foremost any tobacco related habits have to be stopped forthwith to be followed by administration of retinoids and other drugs or other surgical procedures such as surgical excision, cryosurgery, laser surgery and photo dynamic therapy [6]. Laser surgery has been the latest treatment modality for leukoplakia. Different soft tissue lasers, semiconductor Diode laser and hard tissue lasers can be used for the treatment of oral leukoplakia. Today there are different types of lasers available and used in dentistry such as Nd:YAG, Holmium: Yttrium, Aluminium, Garnet, Er, Cr:YSGG laser, Nd:YAP, GaAs, Diode and Argon laser. Thus different types of lasers are used for different soft tissue surgeries [7].

In comparison with conventional scalpel therapy, laser has many benefits such as ease of soft tissue ablation, hemostasis, instant sterilization, reduced bacteremia, reduced edema due to reduced mechanical trauma, and little wound contraction resulting in minimal scar, less intra- operative and post- operative pain, increased patient acceptance or few sutures, no need for topical anesthesia [8,9].

Diode lasers are semiconductor lasers and are generally considered to be soft tissue lasers. Diode lasers have a solid active medium, manufactures from semiconductor crystals, using some combination of Aluminium, Gallium and Arsenide. The available wavelengths are 810 nm, 940 nm and 980 nm. Laser with wavelength of 810 nm is highly absorbed by melanin and hemoglobin, whereas those of 940 nm and 980 nm are strongly absorbed by hemoglobin and water [10]. Er, Cr:YSGG laser belongs to the Erbium family. They are hard tissue lasers with a wavelength of 2780 nm and contain Yttrium, Scandium, Gallium, Garnet doped with Erbium and Chromium. This laser is well

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absorbed by water enabling it to be used on soft tissues without causing thermal damage [11,12].

Very few studies are done in evaluating the effectiveness of Diode laser and Er,Cr:YSGG laser in oral mucosal lesions. Hence, a study was proposed to compare the effectiveness of Diode laser and Er, Cr: YSGG laser in the treatment of oral leukoplakia.

### Aim and objectives

The aim and the objectives of the present study was to compare the effectiveness of Diode Laser and Er,Cr:YSGG Laser in treating oral leukoplakia in relation to bleeding, assessment of pain during procedure, healing after treatment and recurrence of the lesion after one year.

### Methodology

The present comparative study was conducted in the Department of Oral Medicine and Radiology, Ragas Dental College and Hospital, Chennai, Tamil Nadu, India with permission from the ethical committee of Ragas Dental College and Hospital, Chennai prior to the commencement of the study.

The study population included five subjects reporting to Ragas Dental College and Hospital, Out-patient department seeking dental advice and who were from a wide variety of socio- economic background. The age group selected was above 18 years. Clinical examination was done on all the patients coming to out- patient, five subjects were selected who were provisionally diagnosed as having oral leukoplakia involving the length and width of the buccal mucosa and the lesion was measured and entered in a case sheet proforma (Figure 1). History of habits, such as smoking, alcohol consumption and tobacco chewing was recorded in the case sheet proforma with the duration and frequency of use. The patients were advised to cease the habit and were explained about the laser therapy modality. Informed consent to participate in the study were obtained from each of the five patients included in the study in a written format both in vernacular and English language. The treatment was undertaken at Smile Dental Clinic, T.Nagar, Chennai, Tamil Nadu, India.

On all the five patients laser biopsy was done using Diode laser including the lesion and he normal mucosa (Figure 2). The specimen was stored in 10% formalin and was transported for histopathological analysis to the oral pathologist. Each patient was then prepared by dividing the lesions into two halves with the help of a hematoxylin marker with the maxillary and mandibular premolars being the reference points. Anterior to the marked line, the lesion on the buccal mucosa was treated with Diode laser. The Diode laser (EzLase 940, Biolase, USA) was used in the wavelength of 940 nm, power of 1.00 watt, 615 Joules using contact mode (Figure 3). The lesion area posterior to the marked line on the buccal mucosa was treated with Er, Cr:YSGG laser. The Er,Cr:YSGG laser (Waterlase MD, Biolase, USA) was used in the wavelength of 2780 nm, S mode, 1.5W, Air-30% and Water 10%, MZ , 25 Hz (Figures 4 and 5).

During the procedure the patients were assessed for pain with the use of Behavioral Observational Pain Rating Scale and the scores were entered in the case sheet. Bleeding was assessed intra-operatively during the Diode and Er, Cr:YSGG laser procedures and the results were then entered into the case sheet proforma. Minimal bleeding was scored as '1' and profuse bleeding was scored as '2'. The patients were assessed for post-operative pain using 'Faces' Pain Rating Scale starting from day one immediately after the procedure and day after



**Figure 1:** White lesion present in the right buccal mucosa provisionally di.



**Figure 2:** Diode laser setting for Diode laser procedure.



**Figure 3:** Er, Cr:YSGG laser setting for Er, Cr:YSGG laser procedure.

the procedure for all 7 post- operative days. They were asked to denote pain which they were experiencing by identifying the emotion icon on the scale. The emotion icons expressed were then correlated to a scale which was divided into six scores ranging from 0-5. The pain scores on the day of treatment and for the 7 post- operative days following the day of treatment were then entered into the case sheet proforma for each case for both Diode and Er, Cr:YSGG laser procedures. The Visual



Figure 4: Laser incision done for biopsy using Diode laser.



Figure 5: Laser procedure done.

Analogue Scale was used to assess pain which was experienced by the patient immediately after the procedure and for 7 post-operative days following treatment scoring pain with a scale ranging from 0 to 10. Asking the patient to score the experience of pain with '0' denoting no pain, '5' denoting distressing pain, '10' denoting unbearable pain and if experienced pain between these ranges denoted by respected numbers from 1-4, 6-9. The scores were entered into the case sheet proforma.

Photographs were taken using DSLR camera (Nikon 550D) during the treatment and on 7th, 14th and 21st post-operative days to assess wound healing by visual method.

The recurrence of the lesion was assessed after one year of the study by observing the clinical appearance of the lesion in the buccal mucosa as well as histopathological presentation.

All the data's were then entered in Microsoft excel sheets. Statistical analysis was done using SPSS software SYSTAT Version 15.0. The statistical analysis was done using Chi-Square test, Independent and Paired 't' test and Friedman test. The test of significance with p-value less than 0.05 at 95% confidence interval was taken to correlate the variables to determine the significance.

## Results and Discussion

The results from the present study in relation to pain using Behavioral pain rating scale, "Faces" pain rating scale and visual analogue scale:

In the present study, pain was assessed for each patient using Behavioral Pain Rating Scale separately during the Diode laser

procedure and Er, Cr:YSGG laser procedure. On comparing the results obtained from all five patients, Behavioral Pain Rating Scale yielded insignificant results with a p-value of 0.061 (Table 1). So far no study has been reported in the literature using the Behavioral Pain Rating Scale to compare between Diode laser and Er, Cr:YSGG laser. In this study for the first time we have attempted to analyze pain using Behavioral Pain Rating Scale in Diode laser and Er, Cr:YSGG laser in the treatment of oral leukoplakia.

A diagrammatic representation of the pain experienced by the patient using 'Faces' Pain Rating Scale was assessed immediately after the laser surgery using Diode and Er, Cr:YSGG laser and seven consecutive days post-operatively starting from the next day after treatment. The emotion icons expressed were then correlated to a scale which was divided into six scores ranging from 0-5. Data analysed from the 'Faces' Pain Rating Scale comparing Diode laser and Er, Cr:YSGG laser on all five patients yielded significant result with a p-value of 0.001 which implied that pain experienced by patients with Diode laser procedure was less in comparison to the use of Er, Cr:YSGG laser. In this present study the analysis of pain reduction post-operatively yielded insignificant results in 'Faces' Pain Rating Scale with a p-value of 0.093 with Diode laser and with Er, Cr:YSGG laser highly significant results were obtained which showed that pain gradually reduced from the first day after treatment and patient experienced no pain on the 5th, 6th and 7th post-operative days in all five patients with Diode and Er, Cr:YSGG laser (Table 2).

No study has been reported using the 'Faces' Pain Rating Scale comparing Diode laser and Er, Cr:YSGG laser. This present study is an attempt to analyse pain using 'Faces' Pain Rating Scale comparing Diode laser and Er, Cr:YSGG laser in the treatment of oral leukoplakia.

In this present study Visual Analogue Scale was also used in all five patients to assess pain experienced by patient after the Diode and Er, Cr:YSGG laser procedure. It was observed that on comparing Diode laser and Er, Cr:YSGG laser to assess pain the Visual Analogue Scale yielded highly significant results with a p-value of 0.000 (Table 3). This implied that Diode laser procedure caused minimal pain when compared to Er, Cr:YSGG laser in treatment of oral leukoplakia.

It was observed in the present study that pain reduced gradually

	Mean	N	Std. Deviation	Std. Error Mean	Sig.
Diode laser	2.40	5	4.336	1.939	0.061
Er,Cr:YSGG laser	5.00	5	3.082	1.378	

Table 1: Data analysis of Diode laser and Er, Cr:YSGG laser obtained by the use of Behavioral Observation Scale.

	Immediately After treatment	1 <sup>st</sup> post op day	2 <sup>nd</sup> post op day	3 <sup>rd</sup> post op day	4 <sup>th</sup> post op day	5 <sup>th</sup> post op day	6 <sup>th</sup> post op day	7 <sup>th</sup> post op day	P value
Diode laser	5.80	5.60	4.60	4.40	4.20	3.80	3.80	3.80	0.093
Er, Cr:YSGG laser	7.90	7.10	4.00	3.80	3.60	3.20	3.20	3.20	0.000

Table 2: 'Faces' Pain Rating Scale in Diode and Er, Cr:YSGG laser immediately after the procedure and 7 post-operative days.

	Mean	N	Std. Deviation	Std. Error Mean	Sig.
Diode laser	6.60	5	13.107	5.862	0.000
Er,Cr:YSGG laser	11.40	5	10.991	4.915	

Table 3: Data analysis of Diode laser and Er, Cr:YSGG laser obtained by the use of Visual Analogue Scale.

after the treatment with no pain experienced by the patient on the 5th, 6th and 7th post-operative days in both Diode and Er, Cr:YSGG laser. The analysis yielded significant results with Diode laser with p-value of 0.025 and yielded with Er, Cr:YSGG laser (Table 4).

In the present study the post-operative analysis as expressed by each individual patient using 'Faces' Pain Rating Scale and Visual Analogue Scale is unique with the sense that each patient had separately experienced both the laser procedures using Diode laser and Er, Cr:YSGG laser and that their experiences of pain under each procedure became all the more significant in comparing both the procedures than if it were done by two different groups of unrelated patients under each laser procedure.

In this present study bleeding was assessed visually during both the Diode laser and Er, Cr:YSGG laser procedure. It was found that in all five patients during Diode treatment minimal bleeding was observed during ablation and needed only occasional wiping of the area, whereas in all five patients during Er, Cr:YSGG laser ablation profuse bleeding was observed which needed continuous wiping of the area with cotton roll, hemostasis was achieved after 2-3 times of wiping the area with the cotton roll (Table 5 and Figure 6). This is in accordance to the study conducted by George Romanos et al. [13] in which Diode laser (980 nm) was used in the removal of soft tissue tumors and was observed that minimal bleeding was seen. Goharkhay et al. [14] used Diode laser with 810 nm wavelength on soft tissue lesions resulted in excellent coagulation ability. Deppe and Horch [6] reviewed the use of Diode laser in removal of premalignant lesions of oral mucosa and concluded minimal bleeding during treatment. Also the present study is in accordance to Prajwalit Kende et al. [15] whose case report of excisional biopsies performed on oral premalignant lesion using Diode laser indicated reduced operative blood loss.

The Er, Cr:YSGG laser procedure in this present study showed profuse bleeding (Table 5) which is in accordance to the study reported by Lee [16] who concluded that hemostatic ability is limited with use of Er, Cr:YSGG laser because only the water on the surface of the blood in the surgical site is vaporized. There is neither deep penetration nor sustained heat to provide rapid vessel shrinkage. In the present study hemostasis was well achieved with the use of Diode laser than Er, Cr:YSGG laser which is in accordance with the study conducted by Stabholz et al. [17] which describes that hemostasis is better achieved by use of Diode laser than Er, Cr:YSGG laser because Diode laser are well absorbed by melanin and hemoglobin. Their wavelengths (810-980 nm) will pass through water and penetrate much deeper into the soft tissue unlike Erbium laser where they are not well absorbed by these chromophores concluding that Erbium family lasers are not ideal wavelength for soft tissue surgeries in which ideal hemostasis is desired.

In this present study it was observed that both Diode and Er, Cr:YSGG laser in all five patients showed signs of re-epithelisation with no scarring on the 7th post-operative day, whereas with three patients out of 5 showed slight whitish areas on the 7th post-operative day (Figure 7). Complete healing was observed in all five patients on the 14th post-operative (Figure 8) with the use of both Diode and Er, Cr:YSGG laser and four patients out of five showed normal buccal mucosa on the 21st day (Figure 9). Except for one patient who showed no successful healing with whitish area surrounding the region on 14th post-operative day with the use of both Diode and Er, Cr:YSGG laser and the patient was not willing for anymore review and did not return back on the 21st day (Table 6). The patient gave the reason of unable to quit smoking and alcohol consumption and was obviously continuing

	Immediately After treatment	1 <sup>st</sup> post op day	2 <sup>nd</sup> post op day	3 <sup>rd</sup> post op day	4 <sup>th</sup> post op day	5 <sup>th</sup> post op day	6 <sup>th</sup> post op day	7 <sup>th</sup> post op day	P value
Diode laser	6.50	5.50	4.50	4.30	4.10	3.70	3.70	3.70	0.025
Er, Cr:YSGG laser	8.00	7.00	6.00	3.40	3.20	2.80	2.80	2.80	0.000

Table 4: Visual Analogue Scale in Diode and Er, Cr:YSGG laser immediately after the procedure and 7 post-operative days.

	Case 1	Case 2	Case 3	Case 4	Case 5
Diode laser	1	1	1	1	1
Er, Cr:YSGG laser	2	2	2	2	2

Table 5: Comparison of Bleeding during the procedure between Diode and Er, Cr:YSGG laser.



Figure 6: Diode laser used in anterior half and Er, Cr:YSGG laser procedure.



Figure 7: 7th post-operative day wound healing.

with the habits all through the post-operative period rendering the healing process to fail. In this study it was observed that out of five patients except for one patient all other showed excellent wound healing at the 21st post-operative day which is in accordance to George Romanos et al. [13] study which examined wound healing of soft tissue after application of Diode laser and concluded that good wound healing was observed. Mona Soliman et al. [18] also showed similar results with complete wound healing after second week in treatment of oral lichen planus with Diode laser. Deppe and Horch [6] in his study also concluded that premalignant lesions treated with Diode laser showed excellent wound healing. In accordance to the present study, a study conducted by Nilesh Ravel et al. [19] showed complete wound healing with the use of Diode laser.



Figure 8: 14th post-operative day wound healing.



Figure 9: 21st post-operative day wound healing.

In the similar way Er, Cr:YSGG laser in this present study showed excellent wound healing which is in accordance to the study conducted by Rizolu et al. [20] who concluded that all 12 mucocutaneous soft tissues treated using Er, Cr:YSGG laser showed good signs of re-epithelisation. And Boj et al. [21] study on squamous cell papilloma treated with Er, Cr:YSGG laser also showed excellent wound healing similar to this present study. In this present study Diode laser and Er, Cr:YSGG laser showed good wound healing after 14th post-operative day which is not in accordance to the study conducted by Jin et al. [22], the study was a comparative study to assess healing of buccal mucosa

in 24 guinea pigs and it was concluded that Diode laser has better effect on wound healing when compared to Er, Cr:YSGG laser.

No recurrence was observed clinically as well as histopathologically after one year of treatment using both the Diode and Er, Cr:YSGG laser.

This is a pioneer study in which the effectiveness of Diode laser with a wavelength of 940 nm has been compared with the effectiveness of Er, Cr:YSGG laser with a wavelength of 2780 nm which is a hard tissue laser. In this present study it was noted that both Diode laser and Er, Cr:YSGG laser showed excellent wound healing post-operatively concluding that both the lasers can be used in the treatment of oral leukoplakia. In relation to hemostasis, Diode laser was found to be superior to Er, Cr:YSGG laser as Diode laser is well absorbed by hemoglobin, whereas Er, Cr:YSGG laser is absorbed by water and hydroxyapatite crystal. In relation to pain, both the laser caused minimal pain during the procedure except for one patient who experienced severe pain with the use of both the lasers which concluded that pain can be subjective. Diode laser is less painful when compared to Er, Cr:YSGG laser because the wavelength of 940 nm is less when compared to Er, Cr:YSGG laser wavelength which is about 2780 nm which could cause more thermal damage causing more pain compared to Diode laser. Moreover Diode laser was portable and easy to handle and less expensive when compared to Er, Cr:YSGG laser.

### Conclusion

The study concluded that Diode laser with the wavelength of 940 nm can be used in the treatment of oral leukoplakia with no to minimal pain, excellent hemostasis and wound healing with no post-operative complications and Er, Cr:YSGG laser being a hard tissue laser with a wavelength of 2780 nm caused minimal discomfort to patient and profuse bleeding during procedure and good healing outcome in treatment of oral leukoplakia concluding that Er, Cr:YSGG laser can also be considered in the treatment of oral leukoplakia. While comparing both the lasers, in this present study it has been concluded that Diode laser (940 nm) is superior to that of Er, Cr:YSGG laser in treating oral leukoplakia. No recurrence of the lesion was found in using both the lasers. Considering the fact of no recurrence for one year, Diode and Er, Cr:YSGG laser can be incorporated in the treatment of oral leukoplakia.

Considering the small sample size used in this present study, the study with large proportion of samples may be necessary to confirm the results of our study conclusively.

Case No.	Days	Diode Laser	Er, Cr:YSGG Laser
Case 1	7 <sup>th</sup> day	Re- epithelisation /no scarring	Re- epithelisation/ no scarring
	14 <sup>th</sup> day	Complete healing	Complete healing
	21 <sup>st</sup> day	Normal buccal mucosa	Normal buccal mucosa
Case 2	7 <sup>th</sup> day	Re- epithelisation / no scarring with slight whitish areas	Re- epithelisation / no scarring with slight whitish areas
	14 <sup>th</sup> day	Complete healing	Complete healing
	21 <sup>st</sup> day	Normal buccal mucosa	Normal buccal mucosa
Case 3	7 <sup>th</sup> day	Re- epithelisation / no scarring with slight whitish areas	Re- epithelisation / no scarring with slight whitish areas
	14 <sup>th</sup> day	Complete healing	Complete healing
	21 <sup>st</sup> day	Normal buccal mucosa	Normal buccal mucosa
Case 4	7 <sup>th</sup> day	Re- epithelisation / no scarring with slight whitish areas	Re- epithelisation / no scarring with slight whitish areas
	14 <sup>th</sup> day	Healing with mild whitish areas	Healing with mild whitish areas
	21 <sup>st</sup> day	Normal buccal mucosa	Normal buccal mucosa
Case 5	7 <sup>th</sup> day	Signs of re- epithelisation seen with no scarring	Signs of re- epithelisation with pin – point bleeding
	14 <sup>th</sup> day	No successful healing, whitish area surrounding the region	No successful healing, whitish area surrounding the region
	21 <sup>st</sup> day	Not willing for review- Did not report back	Not willing for review- Did not report back

Table 6: Comparison of digital photographs after Diode laser and Er, Cr:YSGG laser procedure to assess wound healing on the 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> post operative days.

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