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Comparative Evaluation of Diode Laser and Cryosurgery in Management of Leukoplakia

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Abstract

Oral mucosal lesions are frequently encountered during routine dental or medical examinations. Among them, leukoplakia is a common potentially malignant disorder of the oral mucosa, clinically defined as a white patch or plaque that cannot be rubbed off and cannot be clinically or histopathologically categorized as any other definable disease. This study aims to evaluate and compare two surgical treatment modalities—diode laser and cryosurgery—in the management of oral leukoplakia.

Aims and Objectives: The objective of this study was to assess and compare the clinical outcomes of diode laser and cryosurgical interventions in leukoplakia, with particular emphasis on wound healing parameters such as lesion size, slough formation, scarring, recurrence rate, and postoperative pain.

Materials and Methods:The study included 10 patients diagnosed with bilateral leukoplakia on the buccal mucosa. Each patient received diode laser treatment on one side (Group A) and cryosurgery on the contralateral side (Group B). Clinical evaluations were conducted postoperatively on the 7th day, 14th day, and at 3 months. Postoperative pain was measured using the Visual Analog Scale (VAS), and data were analyzed using the Mann-Whitney U test.

Results: Both treatment modalities showed statistically significant improvements in lesion size, slough, scar formation, recurrence, and postoperative pain. The diode laser group exhibited superior outcomes in terms of reduced postoperative pain and improved wound healing on the 7th and 14th postoperative days compared to the cryosurgery group.

Conclusion: Diode laser therapy is a safe and effective modality for the management of oral leukoplakia. It offers advantages such as minimal postoperative complications, better wound healing, and reduced pain. Moreover, it is relatively cost-effective and well tolerated by patients, making it a preferable choice over cryosurgery in suitable cases.

Key words: Laser, Cryosurgery, Visual Analog Scale (VAS), oral leukoplakia.

Introduction

Oral premalignant lesions of the oral cavity such as leukoplakia and erythroplakia, remain a diagnostic and treatment challenge as they have a potential for malignant transformation. Oral cancer is one of the commonest of all cancers in India. oral cancer in India is caused primarily by the extensive use of betel leaves, arecanut, lime, and tobacco quid, followed by smoking tobacco in various forms. The first line in the management of precancerous lesions is include factors consumption of smoking, tobacco usage, quitting betel quid, and reduction or complete withdrawal of alcohol usage. Various treatment modalities have been described for oral premalignant lesions. These can broadly categorize into surgical and nonsurgical treatments. Numerous methods for the management include a conservative method, such as photodynamic therapy and topical or systemic medical treatment using carotenoids, retinoids, bleomycin, antioxidants, and topical bleomycin. but less chances of complete recovery then Various surgical treatment modalities include conventional surgery, cryotherapy, and laser surgery. In conventional surgery, the surgical techniques such as scalpel excision, electrocoagulation.

Laser surgery has emerged effective modality for leukoplakia. Different soft tissue lasers, semiconductor Diode laser and hard tissue lasers can be used for treating leukoplakia. 4 Lasers provide a bundle of options over conventional surgery as they provide advantage of precision excision, homeostasis, reduced postoperative swelling and pain6,7 as well as ability to decontaminating and bactericidal property.4 Cryosurgery is controlled and targeted destruction of diseased tissue by the application of cold temperature using a cryogen. It is a simple, cost-effective, efficient, and cosmetically acceptable modality.

Both cryosurgery and laser surgery have added advantages like selective removal of the affected epithelium, minimal damage to surrounding healthy tissue along with minimal postoperative pain, edema, and scarring.

The Goal of this study is to evaluate and compare the efficacy of diode laser and cryosurgery in the management of bilateral oral leukoplakia.

Materials and Methods

The study was conducted at Al-Badar Rural Dental College's Department of Oral & Maxillofacial Surgery in Kalaburagi, Karnataka. The institutional ethics committee granted ethical approval. Each participant received a participation sheet with unique explanations in Kannada, Hindi, and English. Following their acceptance, informed consent was acquired. Each research participant was informed of the study's goal and methodology. Each person was given an information sheet and given a verbal explanation of it. The participant gave their informed consent.

Inclusion Criteria: 1. Patients with histopathologically diagnosed leukoplakia bilaterally. 2. Patients with leukoplakia who have failed to respond to the medical line of treatment. 3. Patients in the age group 20-60 years. 4. ASA I and II patients. 5. Patients discontinued habits minimum periods of 6 months. Exclusion Criteria: 1. Patients with active malignancy. 2. Uncontrolled diabetes. 3. Medically compromised.

Clinical assessment

Postoperative pain sensation was assessed postoperatively after one day, fifteen days, one month and three months, by using VAS scale 0 - No pain sensation, 1-3 - Mild pain sensation, 4-6 - Moderate to severe pain sensation, 7-9 - Very severe pain sensation, 10 - Worst pain sensation.

Wound healing

Pre-operatively, the size of the lesions will be measured in anteroposterior and super-inferior dimensions with a vernier caliper. Similarly, the dimensions will be measured at 1st, 2nd week post-treatment for Group A lesion and Group B lesion.

- Assess slough formation at first and second week postoperatively. 0 Absent Clean wound bed, 1 Mild < 25% wound area, thin yellow/ white layer, 2 Moderate 25-50% clearly visible slough, 3 Severe 50-75%, thick & adherent slough layers
- Scar formation at three months postoperatively. 0 - Absent No scar, 1 - Mild Minimal scar, slight discoloration, thin fibrous line, 2 - Moderate Noticeable elevation, visible color, minor contracture/ texture change, 3- Severe Atropic scar, significant fibrosis
- Recurrence of lesion at three months postoperatively on clinical examination 1- Present, 2- Absent.

Surgical procedure

Extra-oral painting was done with 5% Povidone iodine, followed by normal saline, and intraoral flushing with 5% povidone iodine, followed by normal saline. The patient will be operated under local anesthesia 2% lignocaine with adrenaline 1:80000 dilution will be used for haemostasis. One side of the buccal mucosa managed with laser, which will be considered as Group A lesion, and the other side will be managed by cryosurgery and will be considered as Group B lesion. Identify borders and do the outline marking of the lesion using a surgical marker. The treatment should be performed until lesions are completely ablated. In Group A lesion, a 970 nm diode laser will be used in continuous mode to excise the lesion. In group B lesion, the cryosurgery procedure will be performed by direct application of nitrous oxide cryoprobe at a temperature of -65◦ to -85◦ C. The cryoprobe is applied for around 30 seconds following ice ball formation and the tissue will be allowed to thaw completely prior to reapplication of the probe. The cryoprobe is applied for at least two or three freeze-thaw cycles.3 Diode laser and cryosurgery will be performed on the same patients.

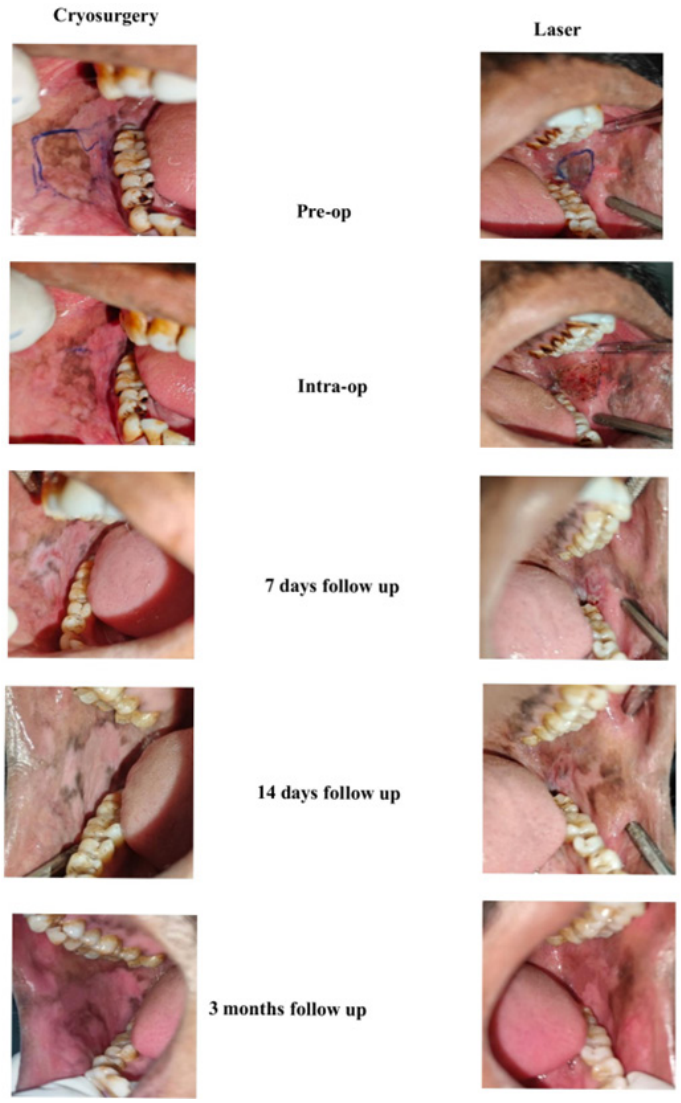

Figure.

Results

This study evaluates the efficacy of diode laser and cryosurgery in the management of oral leukoplakia, a split-mouth study**,** findings suggest that both laser and cryosurgery treatments resulted in gradual reductions in size of treated area over time, with statistically significant (0.001) improvements observed in both groups. The size of treated area decreased consistently across successive time points, indicating effective treatment responses for both methods.

Groups	Time	N	Mean	SD	Min	Max	p-value
Laser	T0	10	17.50	6.92	5	31	<0.001*
	T1	10	17.50	6.92	5	31	
	T2	10	14.90	6.52	4	28	
	T3	10	12.10	5.71	3	22	
Cryosurgery	T0	10	18.60	7.23	10	32	<0.001*
	T1	10	18.60	7.23	10	32	
	T2	10	16.50	6.85	9	30	
	T3	10	14.40	7.00	6	30	

Table 1: Comparison of mean Size (in mm) of treated area in Superior-Inferior direction b/w different time intervals in each group using Friedman's test.

Groups	Time	N	Mean	SD	Min	Max	p-value
Laser	T0	10	30.20	15.48	6	61	<0.001*
	T1	10	30.20	15.48	6	61	
	T2	10	26.90	15.04	5	58	
	T3	10	23.30	14.35	3	52	
Cryosurgery	T0	10	27.10	8.52	9	38	<0.001*
	T1	10	27.10	8.52	9	38	
	T2	10	25.00	8.31	8	36	
	T3	10	21.90	8.44	6	35	

Table 2: Comparison of mean Size (in mm) of treated area in Anterior-Posterior direction b/w different time intervals in each group using Friedman's test.

Time	Groups	N	Mean	SD	Mean Diff	p-value
1 week	Laser	10	2.20	0.92	-1.20	0.01*
	Cryosurgery	10	3.40	1.27		
2 weeks	Laser	10	1.00	0.67	-1.00	0.04*
	Cryosurgery	10	2.00	0.94		

Table 3: Comparison of mean VAS scores for pain between 2 groups at different time intervals using Mann Whitney Test.

Group	Slough	1 Week		2 Weeks		p-value
		n	%	n	%	
Laser	Absent	0	0%	2	20%	0.003*
	Mild	3	30%	6	60%	
	Moderate	5	50%	2	20%	
	Severe	2	20%	0	0%	
Cryosurgery	Absent	1	10%	2	20%	0.04*
	Mild	3	30%	5	50%	
	Moderate	1	10%	1	10%	
	Severe	5	50%	2	20%	

Table 4: Comparison of Slough Formation between different time intervals in each group using Marginal Hormogeneity Test.

Variable	Severity	Laser		Cryosurgery		p-value
		n	%	n	%	
Scar	Absent	10	100%	0	0%	<0.001*
	Mild	0	0%	7	70%	
	Moderate	0	0%	3	30%	
	Severe	0	0%	0	0%	

Table 5: Comparison of Severity Formation between 2 groups using Chi square Test.

Variable	Severity	Laser		Cryosurgery		p-value
		n	%	n	%	
Recurrence	Present	0	0%	2	20%	0.14
	Absent	10	100%	8	80%	

Table 6: Comparison of Recurrence of the lession between 2 groups using Chi Square Test.

Discussion

Postoperative wound healing was comparable between diode laser and cryosurgery. Although diode laser wounds are known to show faster re-epithelialization, dense early inflammation, and a lower risk of secondary infection due to the laser's sterilizing effect, both groups in our study demonstrated similar healing patterns. Evaluation of anteroposterior (A-P) and superoinferior (S-I) wound dimensions on the 7th and 14th postoperative days showed gradual reduction in lesion size in both modalities, with no significant difference between them ($p < 0.001$). These findings align with Narula et al., who reported complete cryotherapy wound healing by the third week. Slough formation commonly occurs after both diode laser surgery and cryotherapy for oral leukoplakia. In diode laser procedures, slough develops due to thermal coagulation and protein denaturation, forming a protective coagulum that covers the wound and usually sheds within the first week as healing advances. In cryotherapy, slough forms from tissue necrosis caused by ice crystal formation and ischemia, with the devitalized tissue separating gradually as the lesion undergoes liquefaction or dry gangrene-like changes. Overall, while the mechanisms differ, slough formation is a normal healing response in both modalities.

Laser-induced coagulum covers the surface, therefore eliminating the need for grafts. Tissue coagulation acts as a dressing, and decreases pain and risk of infection. They experienced lasers caused more collateral damage, especially of the epithelium compared to blade surgery. This may be due to its inherent property of coagulation or of misdirected usage. Therefore, wound healing is delayed because of secondary epithelization, which takes around 3 to 4 weeks.43 Fortunately, that provides more time for active mouth-opening exercises to prevent contracture during healing.

Diode laser therapy is associated with lower post-operative pain scores compared to cryosurgery. The laser ability to seal nerve endings and microvasculature contributes to reduced discomfort in contrast cryotherapy may result in significant edema and tissue sloughing, leading to more pronounced pain during the healing phase.41,45 The reduced thermal damage and precise targeting of the laser contribute to lower pain levels and faster recovery.46 In our study comparison of post-operative pain was done in Mann Whitney Test between intervals of the on the day of surgery, 7th day & 14thdays. The pain levels were consistently lower in the laser group compared to cryosurgery across both time points, with statistically significant differences observed at both the first and second weeks. This finding is by clinical studies recorded in literature, which states that minimal pain in the post-operative period of laser surgery is due to its effect on nerve endings; reduces the thermal damage to surrounding tissue, and sealing of small lymphatic vessels, leading to reduced postoperative pain. Goharkhay et al. in their study showed that the diode laser is very effective because of its excellent coagulation ability.12 Vatsal et al. studied the effect of diode laser in the management of oral leukoplakia and found less postoperative pain and no recurrence in a 1-year follow-up period.47

When the postoperative pain was analyzed based on findings, all the subjects of the cryo group reported mild pain at the first-week follow-up which regressed completely by their second week. This goes by the observations of Narula et al.[49] Mild pain usually exists in subjects treated with cryotherapy because of the deposition of cellular degradation products that affect the peripheral nerves adjacent to the site of therapy.

Slough formation is a common postoperative finding following both diode laser surgery and cryotherapy in the treatment of oral lesions such as leukoplakia. Slough refers to a layer of devitalized, necrotic tissue that covers the wound surface during the initial phase of healing. In diode laser therapy, slough results from thermal coagulation of superficial tissues due to the photothermal effect of the laser. The laser energy causes protein denaturation and cellular death in a controlled zone around the excised tissue, forming a coagulum or char that serves as a biological dressing. This slough layer initially protects the underlying tissue from bacterial contamination and moisture loss but can act as a physical barrier to epithelial migration if excessive. In most cases, the slough separates naturally within the first week as granulation and epithelialization progress, leading to relatively faster healing and minimal scarring.

Laser surgery resulted in better wound healing, less contraction, and scarring due to the reduction in the number of myofibroblasts, even in cases of large areas of ablation. Scar formation, which was seen in patients treated with cryosurgery, was absent in laser surgery-treated groups. Reduction in the number of myofibroblasts and eosinophils51 on the wound surface during the healing process after laser surgery is thought to be associated with no scar formation. However, this scar (following Cryosurgery) settled and disappeared at the end of 3 months postoperatively.52 According to our study, the statistical analysis revealed a highly significant difference in scar severity between the two treatment methods, indicating that laser treatment ($p < 0.003$) was associated with a complete absence of scarring, whereas cryosurgery resulted in varying degrees of residual scars.

Recurrence rates vary between the two modalities. Diode laser therapy has shown lower recurrence rates, with some studies reporting rates as low as 6.5% over extended follow-up periods.25 Cryosurgery may have higher recurrence rates. Potentially due to less precise control over tissue destruction depth. Long-term follow-up is essential in both cases to monitor for recurrence and potential malignant transformation. In the cryo group, where the depth of penetration is very low and superficial, on comparison rate of the recurrence rates in both, the study group revealed a significantly higher number of recurrences noticed in the Cryo group ($p < 0.14$) and not in the diode group, which was similar to the findings of Varun Kumar et al.29 While both methods are minimally invasive and patient-friendly, diode lasers offer advantages like precise lesion control, rapid healing, less discomfort, anleukoplakia, as supported by several studies including those by Kharadi et al., Kundoor et al., and Chaudhri et al. d superior hemostasis. These benefits make diode laser an optimal choice for managing oral cavity.

Conclusion

This study evaluates the efficacy of diode laser and cryosurgery in the management of oral leukoplakia, a split-mouth study in the Department of Oral and Maxillofacial Surgery.The comparative analysis of laser and cryosurgery treatments revealed distinct trends in lesion reduction, pain levels, slough formation, scar prevention, and recurrence outcomes. Both techniques demonstrated efficacy in reducing the size of the treated area over time, with progressive declines observed across successive intervals ($p < 0.001$).Laser treatment resulted in lower pain scores at all time points, suggesting a more comfortable healing process compared to cryosurgery ($p < 0.001$).Slough formation followed different trajectories between the two groups, with laser treatment (p value 0.003) facilitating a rapid transition toward absent or mild slough, whereas cryosurgery (p value 0.04) retained a higher proportion of severe cases in earlier intervals. Scar formation was notably absent in all laser-treated cases, whereas cryosurgery resulted in mild to moderate scarring, highlighting differences in post-treatment healing ($p<0.001$). Recurrence was exclusively noted in cryosurgery-treated cases, while laser treatment demonstrated complete lesion resolution ($p = 0.14$). Overall, laser treatment exhibited favorable results across multiple parameters, with advantages in pain reduction, lesion shrinkage, slough resolution, scar prevention, and recurrence control. Cryosurgery also facilitated improvements but displayed variations in healing patterns. Both diode laser therapy and cryosurgery are effective and & relatively safe treatment options for oral leukoplakia. Diode laser therapy offers advantages in terms of precision, reduced postoperative pain, faster healing, and lower recurrence rates. These findings suggest that while both treatments are effective, laser therapy may offer superior post-treatment outcomes, minimizing patient discomfort and enhancing recovery.

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