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EVALUATION OF THE EFFECT OF DIODE LASER THERAPY ON POSTOPERATIVE SENSITIVITY IN NON CARIOUS CERVICAL LESIONS RESTORED WITH ACTIVA™ BIOACTIVE RESTORATIVE™ -A RANDOMISED CONTROL TRIAL

Dr. Naveen Kumar K[1], Dr. Krishnaprasada L[2], Dr. Karthika S Raj[3]

[1]MDS, Reader, Department of Conservative Dentistry and Endodontics, KVG. Dental College and Hospital Kurunjibagh, Sullia, Karnataka

[2]MDS, DNB, MBA, HOD, Department of Conservative Dentistry and Endodontics, KVG Dental College and Hospital Kurunjibagh, Sullia, Karnataka

[3]Postgraduate, Department of Conservative Dentistry and Endodontics, KVG Dental College and Hospital, Kurunjibagh, Sullia, Karnataka

Conflicts of Interest: Nil

Corresponding author: Dr. Karthika S Raj

Abstract:

AIM

- To assess the clinical effect of low level laser therapy just before placement of Activa™ Bioactive Restorative™ on Postoperative Sensitivity (POS) in Non Carious Cervical Lesions(NCCLs)

Materials and Methods

15 patients with two NCCLs were included (two different quadrants). Diagnosis depended on the chief complaint and a detailed history of the patient's perception of sensitivity to thermal stimuli, sweet or sour foods, drinks and to tooth-brushing. The teeth were randomly assigned into two groups.

- Group I- Chair side application of Activa without laser irradiation
- Group II- Chair side application of Activa after laser irradiation

The two groups were subjected to tactile and air stimuli for assessing POS immediately, 14th, and 30th day after the treatment. Responses were recorded using VAS. The teeth in group II were subjected to irradiation from a low-power red laser of 810 nm, which was applied for 1 min on the axial wall of the cavity. Then, adhesive was applied after etching and prepared areas were restored with Activa Bioactive Restorative. In the Group I, the same procedure was performed but without laser simulation.

Statistical Analysis: Data were analyzed using SPSS V 23 software. Mean and Standard deviation were calculated. Independent T test was done to compare the values between two groups at different time intervals. Intragroup analysis was done using One way ANOVA. Tukey's HSD post hoc test was done for multiple comparison.

Results: Pain scores after restorative procedures were significantly lower in the Group II compared to Group I ($p<0.05$). Although both groups experienced a significant improvement in postoperative discomfort throughout the follow-up periods ($p<0.001$), the changes in visual analogue scale (VAS) scores between baseline and each follow-up examination were significantly greater in the Group II than the Group I ($p<0.05$).

Conclusion: Low-level laser therapy (LLLT) before placement of Activa Bioactive Restoration could be suggested as a suitable approach to reduce POS in NCCLS. Further more studies were warranted for generalising the results.

Keywords: Non Carious Cervical Lesions, Low-level laser therapy, Postoperative sensitivity, composite restoration

Introduction

Management of Non-Carious Cervical Lesions (NCCLs) is a challenge, because in most of the cases, cervical margin is located in cementum or dentin. It makes the cervical margin more susceptible to microleakage, which in turn results in cavosurface stains, postoperative sensitivity and the incidence of carious lesions.[1] Managing NCCLs is technique sensitive and may lead to failure of adhesive restorations due to a variety of factors like improper isolation, adhesion to enamel, dentin or cementum etc. [2]

Glass Ionomer Cement (GIC), resin modified GIC and composite resin are widely used in restoring NCCLs. Out of these, the most popular one is composite resin due to its esthetics and strength. However it has polymerization shrinkage, which is the main drawback.[2,3]

Bioactive restorative materials are a relatively new concept in dentistry which has more fluoride release than GIC which can react to pH changes in the mouth by uptaking calcium, phosphate, and fluoride ions to maintain the chemical integrity of the tooth structure.[4] Activa™ Bioactive Restorative™ (Pulpdent, USA) is one such material which comprises of a patented bioactive shock-absorbing rubberized ionic-resin (Embrace resin) matrix without Bisphenol A, Bis-GMA or BPA derivatives.[5,6]

Research is going on towards the development of an ideal restorative material as well as new adhesives to reduce the microleakage and enhance the bond strength. However, despite the advances in this field, postoperative sensitivity still remains a challenge.[5,6]

Umana et al. studied dentinal tubules sealing by means of diode lasers (810 and 980 nm) with powers of 0.8, 1, 1.6, and 2 W for irradiating 24 third molars and revealed that applied lasers with powers of 0.8 and 1 W both could be used for sealing dentinal tubules and were harmless to the health of the pulp. Low level lasers are believed to stimulate circulation and cellular activity and to provide various effects such as anti-inflammatory, vascular, analgesic, and tissue healing.[7]

Moreover, to the best of knowledge, there are no clinical trials in finding out the reduction of POS after laser irradiation in NCCLS restoring with Activa Bioactive Restorative, although the efficacy of Low Level Laser Treatment (LLLT) for treating dentinal hypersensitivity has been evaluated in several studies.[8] Therefore, this study was aimed to evaluate the clinical effect of applying a low level laser after cavity preparation and just before placement of Activa Bioactive restorative on postoperative sensitivity in class V restorations during a 1-month follow-up period.

AIMS & OBJECTIVES OF STUDY:

AIM

- To assess the clinical effect of low level laser therapy just before placement of Activa Bioactive restorative on postoperative sensitivity in NCCLs.

OBJECTIVES

- To assess the postoperative sensitivity in NCCLs restored with Activa bioactive restorative
- To assess the effect of low level laser therapy on postoperative sensitivity in NCCLs before restoring with Activa bioactive restorative

.**METHODOLOGY**

The present in vivo study was conducted at K.V.G Dental College and Hospital, Sullia. The study was done on 15 patients in the age group of 30 – 45 years referred for management of NCCLs to the Department of Conservative Dentistry and Endodontics, K.V.G Dental College and Hospital, Sullia, Dakshina Kannada, Karnataka.

Study population consisted of 15 patients in which each patient having two NCCLS in two different quadrants

• Group I- Chair side application of Activa without laser irradiation

• Group II- Chair side application of Activa after laser irradiation

Testing two different stimuli was employed, air and tactile stimulus. The air stimulus was approximately a 1-second blast from the air syringe of the dental unit. It was directed at the exposed surface of the selected tooth which was isolated mesially and distally from adjacent teeth with the investigator's fingers. Tactile stimulus was given using explorer. The response to sensitivity for both the groups for air pressure and for tactile stimulus were noted. The assessment methods were response based using a Visual analog scale (VAS) score.

INCUSION CRITERIA

- Dentinal hypersensitivity caused by gingival recession or cervical abrasion/erosion
- Preoperative VAS score of ≥2
- Patient with good systemic condition and minimum two sensitive teeth present in two different quadrants (buccal/ facial aspects).

Exclusion Criteria

- Teeth with caries,defective restorations, occlusal restorations, and chipped teeth
- Deep periodontal pockets (probing depth >6 mm)
- Periodontal surgery within the previous 3 months
- Subjects with orthodontic appliances or bridge work
- Cervical defect >2 mm horizontally
- Use of desensitizing toothpaste in the last 3 months
- Chronic or recent use of anti-inflammatory and analgesic drugs, previous treatment for dentinal hypersensitivity

The study was initiated subsequent to approval of institutional Ethical Committee. Informed consent was obtained from the compliant patient after explaining the rationale and objective of the study

Diagnosis of the dentinal hypersensitivity depended on the chief complaint and a detailed history of the patient's perception of sensitivity to thermal stimuli, sweet or sour foods, drinks and to tooth-brushing. During the clinical examination, pain from dental caries and periodontitis were eliminated. All the enrolled patients underwent ultrasonic scaling with proper oral hygiene instructions prior to the study. Then they were randomly allocated into two groups by chit picking method. All the two groups were subjected to tactile and air stimuli at baseline and before each treatment session. The patient's response was recorded with the VAS scale from 0-10, where 0 is the lowest score meaning no pain and 10 is the highest score meaning extreme pain or discomfort. The teeth in group II were subjected to irradiation from a low-power red laser of 810 nm, which was applied for 1 min on the axial wall of

the cavity. Then, adhesive was applied after etching and the cavities were restored with Activa Bioactive Restorative. In group I, the same procedure was performed but without laser simulation .The two groups were subjected to tactile and air stimuli for assessing postoperative sensitivity immediately, 14th, and 30th day after the treatment.

Statistical Analysis

The collected data was statistically analyzed with the help of SPSS Version 23 software. The mean VAS scores was calculated from all the subjects who were taking part in the study. The effectiveness of laser therapy before restoring with Activa Bioactive Restorative was determined by comparing the scores of the two groups at each evaluation period. Independent T test was done to compare the values between the groups at different time intervals. Intragroup analysis using One way ANOVA assessed the changes in postoperative sensitivity in each group during the experiment. Tukey's HSD post hoc test was done to compare the difference in stimuli in all the two groups. The significance level of the tests were set at $p<0.05$.

Results

All the patients included in the study completed the entire follow-up period. Table 1 presents the mean and standard deviation (SD) of POS in the two groups before the treatment and at the three follow-up periods (days 1, 14, and 30) along with T test values. At baseline examination, the mean VAS scores of the group I and II were 5.5333 and 5.8667 respectively. The statistical analysis displayed that the sensitivity to air and tactile stimuli was not significantly different among the two groups. In the intragroup comparison using One way ANOVA revealed that values are statistically significant between the groups and within the groups (Table 2). On multiple comparison using Post Hoc Test, in both the groups, baseline values showed statistically significant difference in all different time intervals (Table 3). The group II exhibited a significantly higher decrease in VAS compared to the group I in 14 th and 30 th day as depicted in Table 1 and 3.

Table 1: Independent T test

Assessment Time	Groups (n= 15)	Mean	Std. Deviation	Std. Error Mean	T test	P value
Baseline	Group I	5.5333	2.09989	0.54219		
Baseline	Group II	5.8667	1.92230	0.49634		
					-0.453	0.654
Immediate	Group I	1.7333	1.08342	0.27974		
Immediate	Group II	1.1000	0 .80623	0.20817		
					1.816	0.080
Days 14	Group I	1.2000	0 .95991	0 .24785		
Days 14	Group II	.4000	0 .43095	0 .11127		
					2.945	0.006
Days 30	Group I	.8000	0 .79732	0 .20587		
Days 30	Group II	.0667	0 .17593	0 .04543		
					3.479	0.002

Table 2: Intragroup comparison

ANOVA

		Sum of Squares	Df	Mean square	F	P value
Group I	Between Groups	213.517	3	71.172	39.870	.000
	Within Groups	99.967	56	1.785		
	Total	313.483	59			
Group II	Between Groups	329.679	3	109.893	96.357	.000
	Within Groups	63.867	56	1.140		

Total	393.546	59

Table 3: Multiple comparison

Tukey HSD

Dependent Variable	Time(I)	Time(J)	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
						Lower Bound	Upper Bound
Group I	Baseline	Immediate	3.80000*	.48787	.000	2.5082	5.0918
	Baseline	14 days	4.33333*	.48787	.000	3.0415	5.6252
	Baseline	30 days	4.73333*	.48787	.000	3.4415	6.0252
	Immediate	14 days	.53333	.48787	.695	-.7585	1.8252
	Immediate	30 days	.93333	.48787	.234	-.3585	2.2252
	14 days	30 days	.40000	.48787	.845	-.8918	1.6918
Group II	Baseline	Immediate	4.76667*	.38995	.000	3.7341	5.7992
	Baseline	14 days	5.46667*	.38995	.000	4.4341	6.4992
	Baseline	30 days	5.80000*	.38995	.000	4.7674	6.8326
	Immediate	14 days	.70000	.38995	.286	-.3326	1.7326
	Immediate	30 days	1.03333*	.38995	.050	.0008	2.0659
	14 days	30 days	.33333	.38995	.828	-.6992	1.3659

*. The mean difference is significant at the 0.05 level.

Discussion

The present study revealed that LLLT after cavity preparation and just before placement of the Activa restorative should be considered as a safe, easy, and effective strategy for reducing postoperative pain and discomfort.

Direct comparisons with previous studies are not possible since no studies are done yet related to reduction of POS in Activa restoration with laser irradiation. But various studies showed diode laser effectiveness in reducing sensitivity in a range of 58.5 – 100%.[2]

As per Corona et al, LLLT was as effective in reducing post treatment discomfort as compared to fluoride varnishes.[5] Matsumoto et al. reported that patients treated with red and infrared lasers reported lesser sensitivity who initially presented light and moderate pain levels.[2]

POS is a subjective symptom so it is difficult to quantify. Thus in the current study, VAS ,a subjective method of pain assessment which has good sensitivity and gives values that can be statistically analyzed easily was used to investigate the degree of POS before and after treatment.[6] Both air and tactile stimuli are physiological in nature and can be easily simulated. Tactile stimulus causes inward displacement of the dentinal fluid which activates the mechanoreceptors in pulp causing pain whereas air stimulus causes outward displacement of the fluid in the open dentinal tubules which again elicit pain. Thus, all the

patients were subjected to both stimuli to avoid subjective mistakes.[9]

Moreover, both groups were assigned simultaneously to each participant since the psychological impact of treatment with a high technology laser apparatus could affect pain perception in each patient and can affect the result.[1,6] Gerschman et al. reported that the mean value of thermal and tactile sensitivity decreased 67 % and 65 % in the laser group compared to 17 % and 21% in the placebo group.[6]

The morphology of the pulp-dentine complex in patients with different age groups may be a determinant factor for tissue response. Regressive or atrophic alterations in the dentine-pulp complex, such as the occurrence of a higher quantity of tertiary dentine, decrease of cellular components, increase in number and thickness of collagenous fibers, reduction in the number and size of odontoblasts and atresia of the neurovascular bundle, are resultant of the physiological process of ageing and of pathological processes..Thus for standardisation purpose, age of the patients selected for the study was 36-45 years.[2]

In the present study, eventhough the improvement in POS was evident immediately after treatment in both the groups and continued to the 1-month follow up period, group II experienced a significantly higher degree of sensitivity reduction compared to group I in all follow up periods throughout the study.

The immediate analgesic effect of lasers might be due to biostimulation and interference with neural transmission in the pulp by blocking the depolarisation of nerve fibres and by occluding or narrowing of the dentinal tubules. [2,9,10] When applied with a sufficient level of intensity, laser caused an inhibition of action potentials by forming reversible varicosities (bending of axons) where there is an approximately 30% neural blockade within 10– 20 min of application.[10]

There are no absolute scientific proofs of which would be the most adequate wavelength, time of application, quantity of joules to be applied, number of applications and the interval between them.

In 2004, Bornstein explained the mechanism of diode lasers (980nm) which disarranges the crystalline dentine structure and causes melting of the dentinal tissues.[3,9] Umana et al and Ying Liu et al proved that a diode laser with wavelengths of 810 and 980 nm and power levels of 0.8 and 1 W and Diode laser with settings of 2.0 W and 980-nm could not cause any fissures or cracks in dentinal tubules and any significant morphological changes in the pulp and odontoblasts respectively. [2,9,11] In this study, diode lasers were used at a 810-940 nm wavelength with a power of 1.5 W.[4] Thus we can justify the wavelength and power of laser used in this study.

The patients of both groups had statistically significant reduction in POS ($p<0.001$) in both tactile and air stimulus from baseline to 30 days. This can be correlated to the studies conducted by Matsumoto et al (1988), Alfredo et al (2009) , Umberto et al (2012), Hashim et al (2014) and Rajeshwari et al(2015).[1]

Inspite of the short-term effect of low-power lasers on nerve conductivity, the reduction in postoperative sensitivity due to the healing effect on the pulp was long lasting. As per Ferreira et al. besides its immediate analgesic effect, laser will stimulate the normal physiological cellular functions and thus at subsequent appointments, the pulpal tissue would be less injured and inflamed. Moreover, the laser would stimulate the production of sclerotic dentin, thus promoting the internal obliteration of dentinal tubules.[1,6] This could explain the extended reduction in POS at 14 th day and 30th day after laser irradiation.

Even without laser irradiation, Group I showed reduction in POS. This could be attributed to the ionic resin component which contains phosphate acid groups with antimicrobial properties that can improve the interaction between the resin and the reactive glass fillers that in turn can enhance the interaction with dental structure.[9] The hydrogen ions break off from the phosphate groups through an ionization process are replaced by calcium in the tooth structure and thereby forming a strong resin-hydroxyapatite complex and a positive seal against microleakage also.[9,10] The fifth generation bonding agent used in the present study contains HEMA (2-hydroxy-ethylmethacrylate) in significantly high quantities which has the characteristic of wetting the dentin and has high penetration capacity into the etched dentin. In addition to this , it mixes the hydrophilic and hydrophobic components of the bonding agent into one solution and acts as a co-solvent by dissolving the various components into water providing a stronger bond. These all might be the reasons for reduction in POS in non irradiated groups restored with Activa.[12] Similarly after dentin bonding agent application, the significant decrease in sensitivity might be due to occlusion of dentinal tubules due to formation of resin tags.[13] Thus the immediate values of both groups were not statistically significant.

Thus the present study also reveals the novel approach for reducing POS using Activa restorations .

Conclusion

LLLT after cavity preparation and just before placement of the restorative materials should be considered as a safe, easy, and effective strategy for reducing postoperative pain and discomfort. Moreover, Activa restoration itself has a positive effect in reducing POS. Further more studies with greater sample size are warranted to compare the effects of low-level lasers with other methods of reducing postoperative sensitivity of activa restorations and to elaborate their exact mechanism of action in its application.

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