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Comparative Efficacy Of Diode Laser Vs Iontophoresis Along With Desensitizing Agent In The Treatment Of Dentinal Hypersensitivity: A Randomized Clinical Trial

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Abstract:
Aims: *The aim of this randomized clinical trial was to evaluate and compare the clinical efficacy of diode laser using with topical Potassium nitrate (KNO3) gel and Iontophoresis with NaF gel in the treatment of dentinal Hypersensitivity.*
Methods and Material: *20 systemically healthy patients with Dentinal Hypersensitivity were enrolled in the randomized clinical trial. The patients with dentinal hypersensitivity were randomly allocated into 2 groups: Group I was treated with diode laser and KNO3 gel; Group II with Iontophoresis unit. Sensitivity was recorded using the verbal rating scale before treatment, 10 min after treatment and 7, 15 and 21 days post therapy.*
Statistical analysis used: *The statistical analysis was carried out using Descriptive Statistics at different times between the Groups. The data were entered in Microsoft Excel and analyzed using statistical package for social science (SPSS) version 22 software. The results were averaged (mean ± standard deviation) for continuous data. P < 0.05 was considered as statistically significant.*
Results: *After 10 min ,7th day and 15th day, levels of hypersensitivity were statistically significant among both groups.*
Conclusions: *The present study concluded that Diode Lasers associated with 5%KNO3 topical gel showed significantly greater reduction of DH than Iontophoresis unit.*
Key-words: *(DH) Dentinal Hypersensitivity, Potassium nitrate (KNO3) gel, Iontophoresis, Diode laser,(VRS) Verbal rating scale.*

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I. Introduction

Dentinal hypersensitivity poses a significant challenge in dental practice, affecting individuals of various age groups and compromising their quality of life. The condition arises due to the loss of enamel or gingival recession[1].

Dentin perseptivity is due to activation of A-δ nerve fibers of dentinal tubules by hydrodynamic mechanism of opened or partially occluded tubules[2].

Diode laser therapy minimally invasive approach for managing DH. Desensitization of Nerve Endings by the laser energy selectively targets and seals the open dentinal tubules, reducing fluid ultimately decreases sensitivity[3].

Aim: The aim of this randomized clinical trial was to evaluate and compare the clinical efficacy of diode laser using with topical Potassium nitrate (KNO3) gel and Iontophoresis with NaF gel in the treatment of dentinal Hypersensitivity.

II. Material And Methods

This controlled, single-blinded, parallel clinical study was conducted at the Department of Periodontology C.S.M.S.S Dental college and Hospital, Aurangabad. The patients participating in this study were randomly assigned to different groups with 10 patients in each group. The inclusion criteria for the study involved selecting 20 systemically healthy patients who presented with the chief complaint of dentinal

hypersensitivity (DH). The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from all the patients. The patients were recruited from the outpatient department of Periodontology.

Settings and Design: Study was conducted in department of periodontology. It was experimental in-vivo study

Sample size: 20 patients.

Inclusion criteria:
1. Systemically healthy patients
2. Patients age between 35 – 55 years
3. Patients having minimum of 20 permanent teeth
4. No scaling or any dental procedures carried out in last 6 months.
5. Patients with clinically elicitable dentinal hypersensitivity who were reliable in their response to test measurements.

Exclusion criteria:
1. Exclusion criteria included individuals who reported using desensitizing toothpaste or mouthwash within the preceding 6 months.
2. Pregnant or breastfeeding individuals were excluded from the study.
3. Smokers were not included in the study population.
4. Patients with teeth displaying cracks, significant dental decay, or previous dental restorations were excluded from the study.

Clinical parameters

Verbal rating scale (VRS) used to evaluate the Dentinal hypersensitivity at baseline and at 7, 15, and 21 days after the treatment. The VRS is a four-point scale ranging from 0 (no sensitivity) to 3 (severe sensitivity), with an additional category of 4 (very severe sensitivity) used after the stimulus was removed. The distance between the identifiable cemento-enamel junction (CEJ) and the gingival margin was measured using the clinical attachment level (CAL) method at baseline, and at 7, 15, and 21 days post-treatment.

Procedure methodology

A total of 20 patients diagnosed with dentinal hypersensitivity resulting from periodontal disease or non-carious tooth wear (such as abrasion, attrition, erosion, abfraction at the cervical third area) were included in the study. Three teeth, either single-rooted or multi-rooted, were choosen for evaluation in each patient.

Group I: Diode laser + Topical application of potassium nitrate gel: The selected teeth were isolated using cotton rolls, and a cotton tip applicator was used to apply potassium nitrate (KNO_3) gel (sensodent KF, Indoco Remedies Ltd, India) onto the affected area. The gel was left in place for 1 minute. A diode laser with a wavelength of 650nm(LX16 Dental Diode Lasers - Woodpecker) was used in a noncontact, continuous mode. The laser power ranged from 0.2W to 0.6W, and the laser was applied for 5 consecutive 20-second intervals on the selected teeth. After removing the KNO_3 gel, the procedure was repeated with the laser fiber in contact with the teeth, using the same power range (0.2W to 0.6W). The verbal rating scale (VRS) score was recorded.

Group II: Iontophoresis treatment group: The sensitive teeth were treated using a dental iontophoresis unit (krupa digital iontophoresis) with Fluorovil 1.23% APF gel . The intrested teeth were isolated with cotton rolls and dried. A sponge tray with a thin layer of sodium fluoride (NaF) gel-applied. The tray, equipped with disposable sponges containing NaF gel, was placed in contact with the affected teeth surfaces. The metal electrode having red spiral was held in the patient's hand, while the metal electrode having black spiral was kept in contact with a rectangular slot in the tray. The resistance knob was turned clockwise. The polarity and time were pre-set at a 3 mA output current for 1 minutes. When the set time elapsed, the appliance emitted a beep, indicating the end of the procedure. The tray with the electrode and sponge was then removed from the patient's dental arch. The teeth were evaluated 10 minutes after the treatment, and the VRS score was recorded.

Fig 1 : LX16 Dental Diode Lasers – Woodpecker

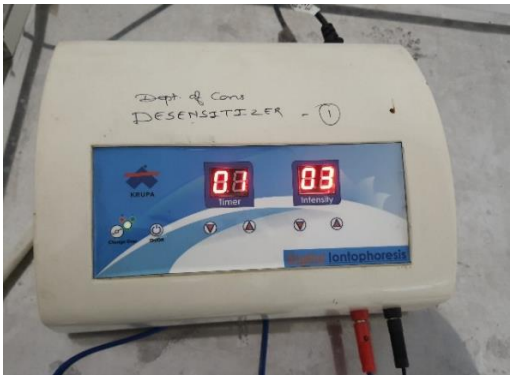

Fig 2 : Krupa digital iontophoresis

Fig 3 : Application of 5 % potassium nitrate gel

Fig 4 : Application of Diode Laser

Fig 5 : Disposable tray and 1.23% APF gel

Fig 6 : Aplication of iontophoresis unit

Follow-up Visits:

All patients were scheduled for recall visits at 10 minutes after treatment, as well as at 7, 15, and 21 days following therapy. During each visit, the same procedure as described earlier was repeated, including the assessment of VRS scores and CAL measurements. Oral hygiene instructions were provided to all patients during each visit. No oral prophylaxis was performed during the recall visits until the end of the evaluation phase. The patients were also monitored for any subjective signs such as ulceration, burning sensation, allergic reactions, and taste alterations. Additionally, objective signs such as redness of the oral mucosa and teeth staining were checked for, and no such reports were made by any of the patients.

Statistical analysis Statistical analysis

The statistical analysis was carried out using Descriptive Statistics at different times between the Groups. The data were entered in Microsoft Excel and analyzed using statistical package for social science (SPSS) version 22 software. The results were averaged (mean ± standard deviation) for continuous data. $P < 0.05$ was considered as statistically significant.

III. Result

TABLE 1 :- Descriptive Statistics at different times between the Groups

Time	Group	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Baseline	Diode Laser + KNO3 Gel	3.60	.516	.163	3	4
	Iontophoresis	3.70	.483	.153	3	4
10 Min	Diode Laser + KNO3 Gel	1.40	.516	.163	1	2
	Iontophoresis	2.80	.789	.249	2	4
7th Day	Diode Laser + KNO3 Gel	.50	.527	.167	0	1
	Iontophoresis	2.10	.876	.277	0	3
15th Day	Diode Laser + KNO3 Gel	.50	.527	.167	0	1
	Iontophoresis	1.30	.675	.213	1	3
21st Day	Diode Laser + KNO3 Gel	.20	.422	.133	0	1
	Iontophoresis	.60	.699	.221	0	2

TABLE 2 :- Descriptive Statistics at different times between the Groups

Time	Group	Mean
Baseline	Diode Laser + KNO3 Gel	3.60
	Iontophoresis	3.70
10 Min	Diode Laser + KNO3 Gel	1.40
	Iontophoresis	2.80
7th Day	Diode Laser + KNO3 Gel	.50
	Iontophoresis	2.10
15th Day	Diode Laser + KNO3 Gel	.50
	Iontophoresis	1.30
21st Day	Diode Laser + KNO3 Gel	.20
	Iontophoresis	.60

TABLE 3 :- Comparison of Hypersentivity Between the groups at different time intervals

		Sum of Squares	df	Mean Square	F	Sig. P value	Result
Baseline	Between Groups	.050	1	.050	.200	.660	Non Significant
	Within Groups	4.500	18	.250			
	Total	4.550	19				
10 Min	Between Groups	9.800	1	9.800	22.050	.000	Significant
	Within Groups	8.000	18	.444			
	Total	17.800	19				
7th Day	Between Groups	12.800	1	12.800	24.511	.000	Significant
	Within Groups	9.400	18	.522			
	Total	22.200	19				
15th Day	Between Groups	3.200	1	3.200	8.727	.008	Significant
	Within Groups	6.600	18	.367			
	Total	9.800	19				
21st Day	Between Groups	.800	1	.800	2.400	.139	Non Significant
	Within Groups	6.000	18	.333			
	Total	6.800	19				

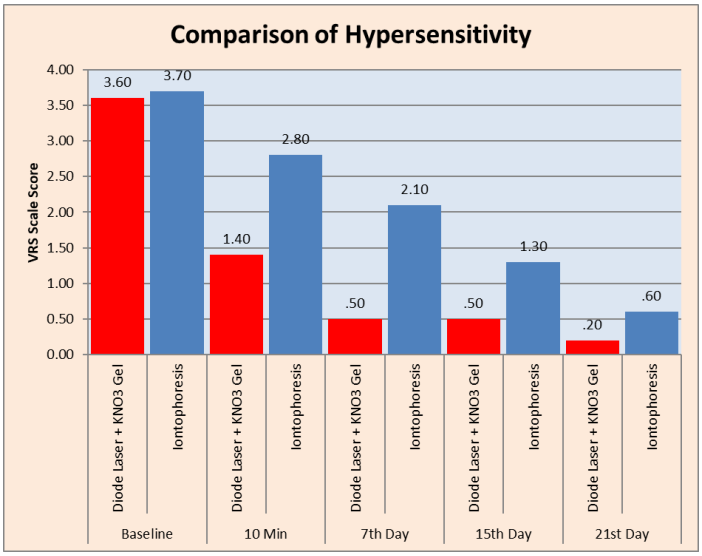

Fig 8 : Comparison of hypersensitivity between the groups on VRS scale

The hypersensitivity between the Diode Laser + KNO3 gel and Iontophoresris is statiscally significant at 10 minutes, 7th day and 15th day. The sensitivity for Doide Laser + KNO3 is less than Iontophoresis at all time intervals except at Baseline and at 21st day. The levels of hypersensitivity were not statistically significant among both groups at baseline and 21st day. But, after 10 min ,7th day and 15th day, levels of hypersensitivity were statistically significant among both groups. On 21th day, both groups showed almost similar results for DH with maximum reduction in group I.

IV. Discussion

There are several propositions about how pain is transmitted in teeth. The most accepted theory is the hydrodynamic theory by Fish (1927), which states that the flow of dental lymph is affected by pressure vibrations in the surrounding tissues. This causes the flow of lymph to either increase or decrease, which is how pain is transmitted. Dentin hypersensitivity is considered as a true pain syndrome. It is a chronic condition with acute exacerbations. Chronic pain has psychological component. Psychic tension can reduce the threshold of tolerance to external stimuli [5].

Preventing DH by addressing the risk factors and promoting good oral hygiene practices. Strategies include proper toothbrushing techniques, use of desensitizing toothpaste and maintaining a balanced diet low in erosive and acidic foods and beverages.

Irradiation using lasers causes various tissue reaction based on the active medium of the laser, its wavelength and the parameters with which the laser was used. For instance, high-power lasers can produce a melting effect on the surface of the irradiated dentin, obliterating the entrance of dentinal tubules, thus arresting intratubular fluid movement, while lasers used at low power during photobiomodulation therapy (PBM) act as a biomodulator of cellular responses and can, if effective, promote the reduction of pain levels through a depolarization of nerve fibers and increase in the formation of tertiary dentin [4].

Tooth hypersensitivity is now recognized as a form of pain. It falls under the category of "allodynia" according to the International Association for the Study of Pain (IASP). Allodynia refers to the perception of pain in response to non-painful stimuli. In a study by Curro (1990), it was suggested that tooth hypersensitivity should be referred to as "allodontia" to more accurately describe the condition. This term highlights the fact that tooth hypersensitivity involves the experience of pain or discomfort from stimuli that would not normally be painful. However, it's important to note that terminology in the field of pain research is subject to ongoing discussion and may evolve over time[6].

The process of assessing and interpreting pain in relation to tooth hypersensitivity can be challenging and subject to individual interpretation. Various methods involving chemical, electrical, and thermal stimuli have been used, but their reliability and validity are still under scrutiny. Additionally, the subjective nature of pain responses and the variability in patients ability to express their experiences further complicate the assessment process. Factors such as the significance of pain, individual personality, psychological aspects, cultural attitudes, and level of apprehension all contribute to the perception of pain.

Evaluating the effectiveness of desensitizing agents in clinical trials can be problematic due to the lack of consistent and reproducible methods for assessing patients' subjective responses. Patients with exposed root surfaces and inadequate plaque control are more prone to dentin hypersensitivity. In this particular study,

scaling procedures were performed on the selected patients, and they were recalled after one week for the application of the desensitizing agent.

It is crucial to develop standardized and reliable assessment methodologies to accurately evaluate the subjective experiences of patients and determine the efficacy of various treatment approaches for tooth hypersensitivity.

Randomized clinical trial was used in the present study, this study was conducted in the age group of 35-55 years as the peak prevalence of DH occurs in that group. Declining hypersensitivity symptoms after the age of 60yrs may be due to the development of secondary or sclerotic dentine which is not affected by mechanical forces. At this time no reopening of dentinal tubules that aid in maintaining the desensitizing effect. Also, tooth wear and periodontal disease become more common with ageing[7]. In this study, scaling was performed on the selected patients and recalled on 7th, 15th and 21th day based on study done by David H. Pasley et al.[8] stated that the smear layer created during manipulation of root surface may last for 5-7 days.

The DH diagnosis confirmed by if positive response obtained during clinical examination in which an air blast from three way syringe was used as stimulus test. Liu et al.[9] reported that 92% of subjects were sensitive to an air blast stimulus. A verbal rating scale VRS was used to assess the various degrees of hypersensitivity. A four point scale that indicate their level of pain in response to hypersensitive stimuli. Clinical Attachment Level (CAL) measurements were taken of selected teeth to assess the gingival recession which results in DH. Three teeth (single rooted or multirooted) were evaluated per patient with hypersensitivity due to periodontal disease (gingival recession) or wasting disease (abrasion, attrition, erosion, abfraction at cervical third area). So this clinical study was carried out employing two methods that is diode laser with KNO3 gel and Iontophoresis with NaF application. Potassium ions in dentifrice act directly on intraductal nerves by raising extracellular potassium ion concentration gradient responsible to prevent further action potential generation by axonal accommodation. It desensitizes the tooth by tooth's neural and vascular components rather than diminishing the dentinal tubule. Iontophoresis acts by influencing ionic motion by electric currents, enhancing ion uptake by the dentinal tubules which results in desensitization. NaF exerts a beneficial, desensitizing effect as it is readily absorbed by dental hard tissues and fluoride ions thus adsorbed under walls of the dentinal tubules as well as on the surface of calcium forms an insoluble compound calcium fluoride (CaF2) with the tooth substance. This yield in creation of physical barrier which narrows dentinal opening that reduces permeability. It was discovered that a reaction between fluoride and the free ions of some electrolytes like calcium make these ions irresponsible for the normal mechanism of pain conduction. Single application of NaF is less effecient as it forms small sized calcium fluoride crystals (approximately 0.05 μm) which can be easily soluble in saliva [10, 11] .

In this study, Diode laser was used in combination with KNO3 gel (G-I). Compared to conventional desensitizing agents, the laser treatment showed rapid results with less application time and more quickly for the patient. this group showed the highest reduction of DH in particular for air blast stimulation. Even though several lasers such as Nd: YAG, Er: YAG, Cr: YSGG lasers have been used, the diode laser has specific wavelengths resulting very safe for the patient. It is easily available and economical[1]. So, the diode laser become more popular and appears to be the most widely used in everyday practice by dentists [12,13]. An innovative 650-nm diode wavelength laser used as it is a high-energy laser with low purchase and maintenance costs as well as greater versatility because of its compact size. Brugnera et al. [14] showed the immediate analgesia causes by using a diode laser.

According to Matsumoto et al.[15] when diode lasers were employed for the treatment of DH, a gradual decrement in tactile and air blast stimuli was experienced on days 15 and 30, when compared to that at baseline and observed 85% improvement in DH. Patil AR. et al.[15] reported that the comparative SEM findings showed statistically significant difference in percentage of totally occluded tubules in the diode laser group. Liu Y et al.[16] who demonstrated that 2 Watt/Continuous wave (166 J/cm²) was favourable parameter for a 650 nm diode laser to seal dentinal tubules without too much melting of the dentin. (Table No. 3)

The limitation of this study was the short observation time after treatment. The sample size was relatively small. The method and interpretation of pain assessment elicited from stimuli and nature of response and variability of patient's ability to express a given response could also introduce some bias which is inevitable.

V. Conclusion

The present study concludes that Diode Lasers combined with a 5% potassium nitrate (KNO_3) topical gel resulted in a significantly greater reduction in dentin hypersensitivity (DH) compared to the Iontophoresis unit. By the 21st day, the maximum reduction in sensitivity, as measured by the Visual Rating Scale (VRS), was observed in the group treated with Diode Lasers and KNO_3 gel.

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