The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
20(2):61-71, 2025 www.thebioscan.com

TO EVALUATE AND COMPARE THE EFFICACY OF LOW LEVEL LASER THERAPY, POTASSIUM OXALATE GEL AND ACIDULATED PHOSPHATE FLUORIDE GEL FOR THE MANAGEMENT OF DENTINAL HYPERSENSITIVITY

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DOI:10.63001/tbs.2025.v20.i02.pp61-71

Received on:
12-03-2025
Accepted on:
15-04-2025
Published on
20-05-2025

ABSTRACT

AIM:-To evaluate and compare the efficacy of low level laser therapy, potassium oxalate gel and acidulated phosphate fluoride gel for the management of dentinal hypersensitivity.

INTRODUCTION:-Dentinal hypersensitivity (DH) is sharp pain from exposed dentin due to chemical, thermal, or mechanical stimuli, primarily caused by enamel loss and gingival recession. The hydrodynamic theory, which links pain to fluid movement in dentinal tubules, is the most accepted explanation. Treatments aim to reduce dentinal permeability through desensitizing agents, lasers, or tubule-blocking substances like ions, salts, and proteins. This study evaluates the most effective material for DH treatment.

OBJECTIVE:-To evaluate and compare pain reduction using VAS with low-level laser therapy, potassium oxalate gel and acidulated phosphate fluoride gel for dentinal hypersensitivity.

METHODOLOGY:-75 sites with dentinal hypersensitivity were included in the study. The selected patients were randomly assigned to one of the treatment groups with 25 sites in each group by computer generated random numbers. Air blast test and cold test were recorded prior to baseline, 1st, 2nd, 3rd and 4th weeks post operatively.

RESULT:-For both cold test and air blast test potassium oxalate gel exhibited notably superior progress, compared to the LLLT group and 1.23% APF gel group. However, VAS scores between low-level laser group and the potassium oxalate group showed no significant difference at 3rd and 4th week.

CONCLUSION:- All three treatment modalities demonstrated a statistically significant reduction in dentinal hypersensitivity over time, highlighting their potential in managing DH. However, the degree and speed of symptom relief varied among the modalities.

INTRODUCTION

Dentinal Hypersensitivity (DH) has been defined as "pain derived from exposed dentin in response to chemical, thermal, tactile or osmotic stimuli which cannot be explained as arising from any other dental defect or disease".[1] The pain is rapid and sharp, originating from the exposed dentin. It is usually the result of chemical, thermal, evaporative, or osmotic stimulation and is not related to any other oral pathology or abnormalities. Loss of enamel on the tooth crown and gingival recession, which exposes the tooth root, is the main causes of DH.[2]

Non-carious cervical lesions (NCCLs) and DH have been described in a number of research involving adult populations. The prevalence rates of these conditions range from 5% to 85%[4] and2-8% to 74%,[5] respectively. The patient's age range of 20 to 50 years is common for the condition. However, it is more common in patients between the ages of 30 and 40, and it is more common in women. This is likely due to their diet and dental hygiene.[6]

DH is most commonly caused by abrasion from inadequate tooth brushing; abfraction from tooth flexion linked to incorrectly directed occlusal forces, parafunctional habits, or occlusal disequilibrium; erosion from acids in the oral cavity; anatomic predisposition brought on by a structural deficit in the cemento-enamel junction; cavity preparations in teeth with pulp viability that reveal the dentine.[7,8]

The etiology of DH is described according to three theories: hydrodynamic theory (movement of the fluid within the dentinal tubules),[9,10] direct innervation theory (direct stimulation of the nerve ends) and odontoblastic transducer theory.[11,12]The second and third theories, however, are not supported by the data, and hydrodynamic theory is still the most widely recognized explanation for the pain associated with DH.[13]

When external stimuli are applied to the surface of exposed dentin with open tubules, dentin hypersensitivity usually occurs. Various stimuli cause the tubules 'fluid to move quickly, changing the pressure and activating pressure receptors near the pulp. Acute discomfort presents itself immediately upon activation.[12]In contrast to other stimuli, heat induces a gradual migration of the dentinal tubule fluid in the direction of the pulp, which lessens the intensity of the pressure receptor activation and, as a result, reduces pain.[14]

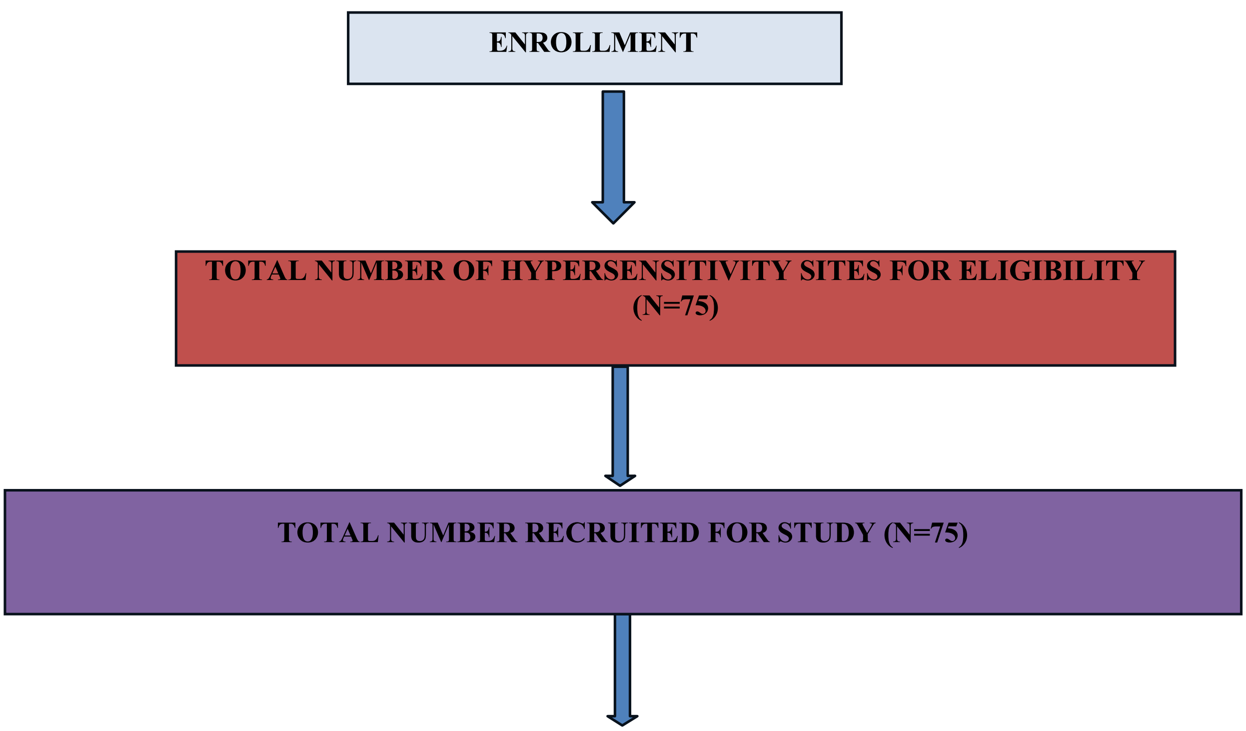
Comparing clinically hypersensitive teeth to non-sensitive teeth, it has been found that the former have a dentin tubule diameter that is about two times larger and an exposed dentin tubule count that is about eight times greater.[15,16] DH must decrease with any therapy that lowers dentinal permeability. Dentinal permeability is reduced when dentinal tubules are blocked, and this diminishes dentinal sensitivity in proportion.[17]

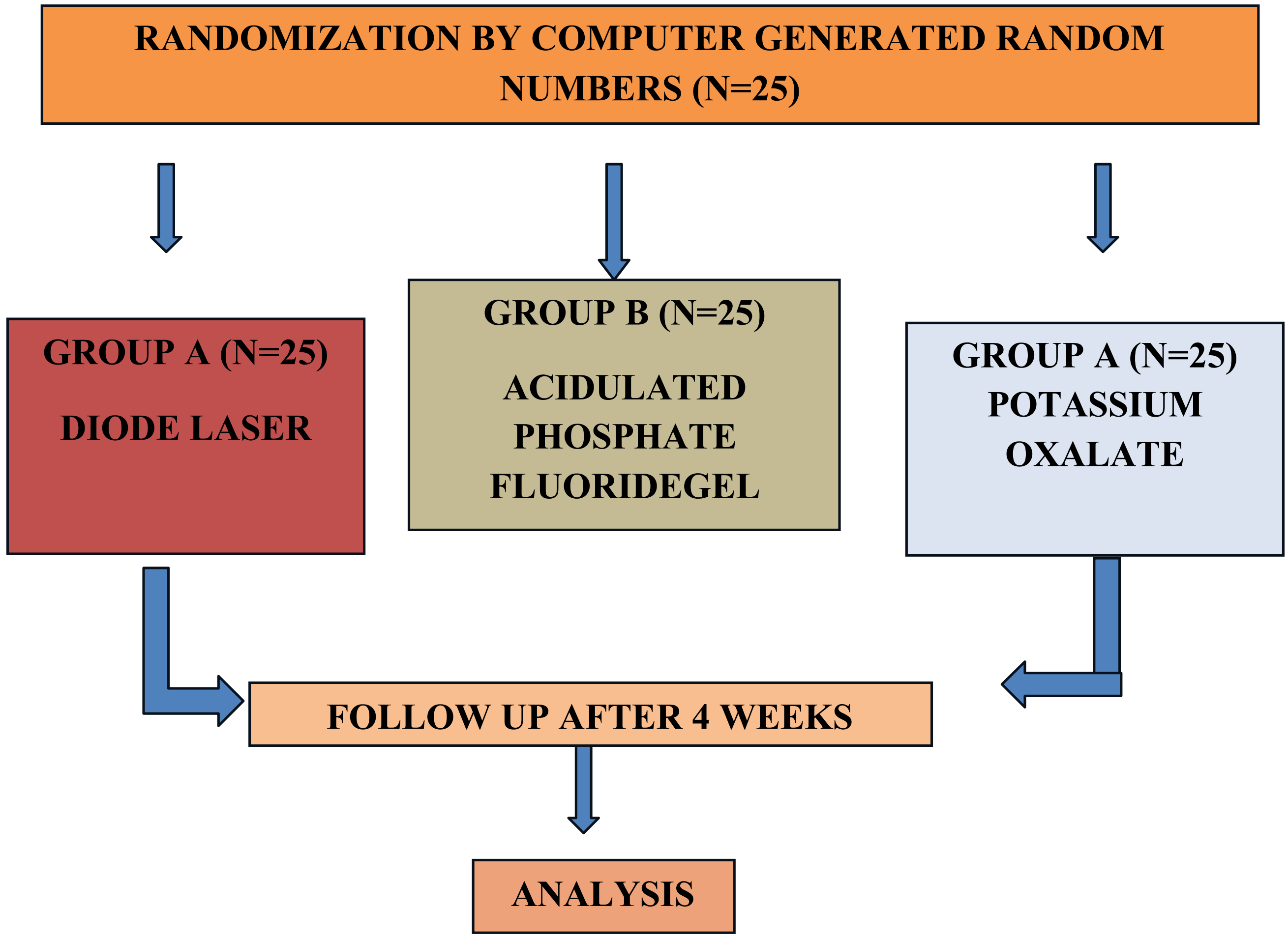
Therefore, there is a continuous research in the field to establish the best material for desensitization. The property of LLLT that acts on biostimulation due to increased mitochondrial ATP production raises the threshold of free nerve endings and provides analgesic effect. The laser also increases the formation of the secondary dentin by odontoblasts in the process of biostimulation[19] In contrast to this there are wide range of therapies, such as the use of ions, salts, and proteins (oxalates, calcium phosphate, fluoride, and hydroxyapatite) to buffer the tubules and physically block stimuli, are based on the partial or total occlusion of dentinal tubules.[20]

This study is done to evaluate and compare the efficacy of low level laser therapy, potassium oxalate gel and acidulated phosphate fluoride gel for the management of dentinal hypersensitivity.

MATERIAL AND METHOD

This study was a 4-week, single-blind, randomized controlled clinical trial conducted in the Department of Periodontology at Inderprastha Dental College and Hospital, Sahibabad, involving 75 sites with dentinal hypersensitivity. Participants were randomly assigned into three groups (25 sites each) to receive one of the following treatments: Group A – Low Level Laser Therapy (LLLT), Group B – Potassium Oxalate Gel, and Group C – Acidulated Phosphate Fluoride Gel. Inclusion criteria required patients to be cooperative, motivated, and exhibit hypersensitive teeth with a VAS score of ≥4, showing signs of abrasion, erosion, or gingival recession. Patients with conditions such as deep caries, large restorations, or recent use of desensitizing products were excluded. All participants underwent Phase 1 therapy including full mouth scaling and root planing, and were provided with oral hygiene instructions. Treatment protocols varied per group, with LLLT applied using an 810nm diode laser in three 1-minute sessions, potassium oxalate applied as a thin film for 1 minute and repeated after 7 days, and fluoride gel applied for 4 minutes as per manufacturer’s instructions. Hypersensitivity was assessed at baseline, 1, 2, 3 and 4 week using air blast and cold tests with a Visual Analogue Scale (VAS). Post-treatment, patients received standardized instructions including dietary advice, gentle oral hygiene practices, and avoidance of desensitizing agents or mouth rinses throughout the study duration.





FLOW CHART1: CONSORT FLOW CHART OF THE STUDY

STATISTICS

Data was analyzed using SPSS software v23. The level of significance was kept at 5%. Data was tested for normality using the Shapiro-Wilk test. Results showed that the data of the RMS scale did not follow a normal distribution, where as the pulse rate data followed the normal distribution. The comparison of air blast test scores and cold test scores between three groups was done using One-way ANOVA test followed by Post hoc Tukey test for group wise comparisons.

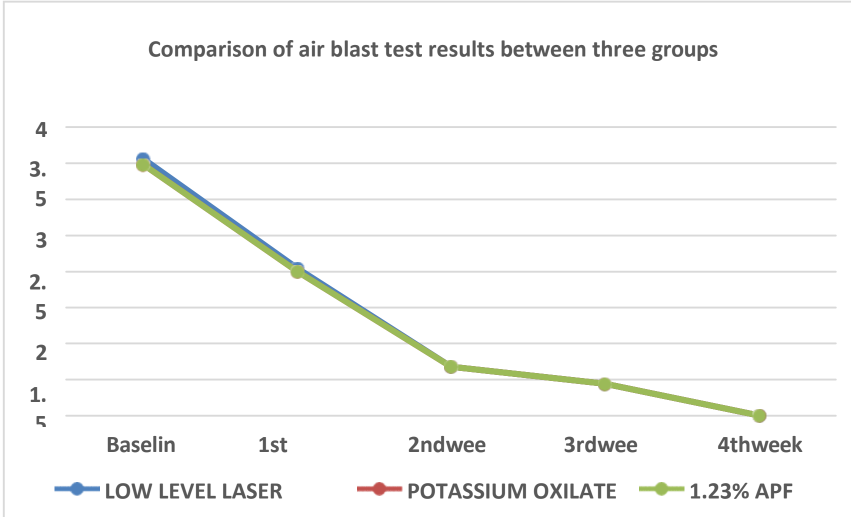
TABLE 1- COMPARISON OF AIR BLAST TEST RESULTS BETWEEN THREE GROUPS

Interval	Group A		Group B		Group C		p-value
	Mean	SD	Mean	SD	Mean	SD	
Baseline	3.56	1.19	3.48	1.16	3.48	1.16	0.962
1st week	2.04	0.89	2.00	0.87	2.00	0.87	0.983
2nd week	0.68	0.63	0.68	0.63	0.68	0.63	1.000
3rd week	0.44	0.51	0.44	0.51	0.44	0.51	1.000
4th week	0.00	0.00	0.00	0.00	0.00	0.00	--

TABLE 2- GROUP WISE COMPARISON OF AIR BLAST TEST RESULTS BETWEEN THREE GROUPS

Interval	Group A vs Group B	Group A vs Group C	Group B vs Group C
Baseline	p=0.968	p=0.968	p=1.000
1st week	p=0.986	p=0.986	p=1.000
2nd week	p=1.000	p=1.000	p=1.000
3rd week	p=1.000	p=1.000	p=1.000

GRAPH 1- INTER GROUP COMPARISON OF VAS SCORE FOR AIR BLAST TEST



GRAPH2- INTRA GROUP COMPARISON OF VAS SCORE FOR AIR BLAST TEST

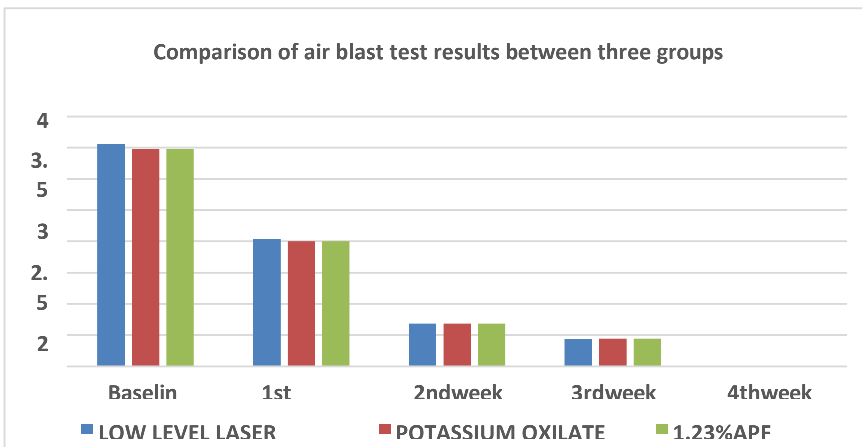


TABLE 3- COMPARISON OF COLD TEST RESULTS BETWEEN THREE GROUPS

Interval	Group A		Group B		Group C		p-value
	Mean	SD	Mean	SD	Mean	SD	
Baseline	5.64	2.06	6.36	1.11	5.84	0.99	0.208
1st week	4.12	1.83	4.88	0.73	4.64	0.81	0.090
2nd week	2.68	1.41	2.92	0.81	3.12	0.60	0.303
3rd week	1.44	1.04	1.40	0.76	2.04	0.54	0.010*
4th week	0.48	0.65	0.20	0.41	1.08	0.70	<0.001*

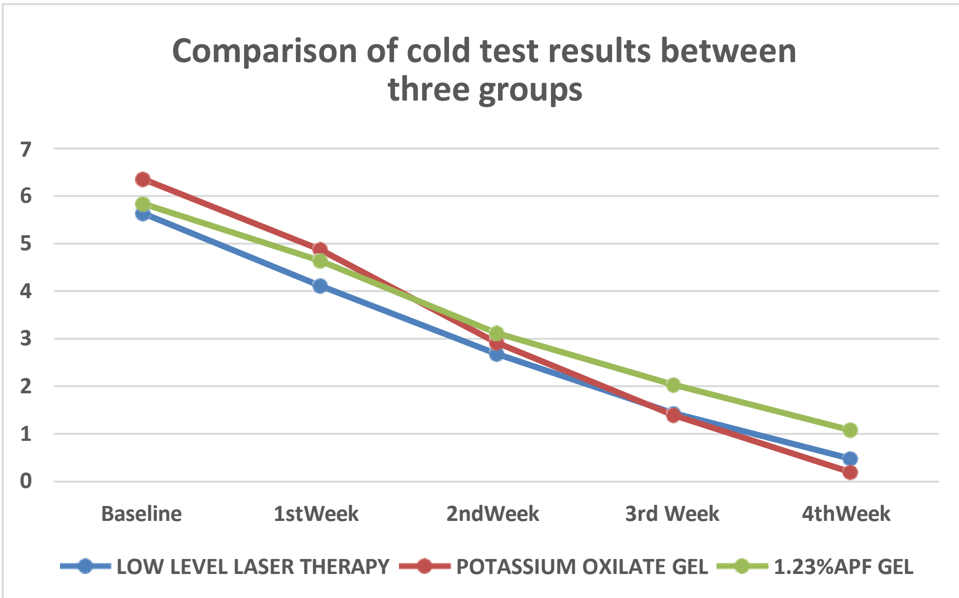
*indicatesasignificantdifferenceatp≤0.05

TABLE 4- GROUP WISE COMPARISON OF COLD TEST RESULTS BETWEEN THREE GROUPS

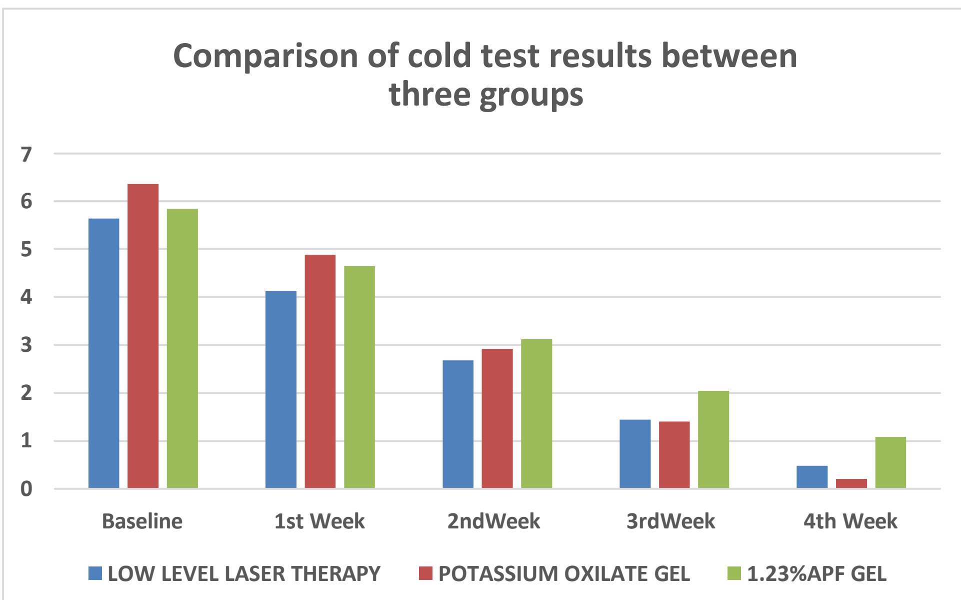
Interval	Group A vs Group B	Group A vs Group C	Group B vs Group C
Baseline	p=0.199	p=0.880	p=0.426
1^{st}week	p=0.081	p=0.300	p=0.770
2^{nd}week	p=0.674	p=0.271	p=0.760
3^{rd}week	p=0.983	p=0.028*	p=0.018*
4^{th}week	p=0.234	p=0.002*	P<0.001*

*indicatesasignificantdifferenceatp≤0.05

GRAPH 3 - INTER GROUP COMPARISON OF VAS SCORE FOR COLD TEST



GRAPH 4 - INTRA GROUP COMPARISON OF VAS SCORE FOR COLD TEST



RESULT

The air blast test was conducted to evaluate dentinal hypersensitivity across the three treatment groups—low-level laser therapy (LLLT), potassium oxalate gel, and 1.23% APF gel. At baseline, no significant differences were observed in Visual Analog Scale (VAS) scores among the groups ($p = 0.962$), confirming comparable initial sensitivity levels. Post-treatment assessments from the1st to the 4th week revealed a progressive reduction in sensitivity across all groups. By the 4th week, the VAS score reached0.00in all groups, indicating complete relief from hyper sensitivity. Statistical analysis confirmed no Significant differences between the treatments at any time point
($p> 0.05$). These findings suggest that all three modalities were equally effective in eliminating dentinal hypersensitivity when measured by the air blast test. In contrast, the cold test provided additional insights into treatment efficacy. From baseline to the 2nd week, no significant differences were observed in VAS scores among the groups($p>0.05$).
However, by the 3rd and 4th weeks, significant differences emerged ($p < 0.05$). The1.23% APF gel group exhibited the highest VAS scores, indicating less effective desensitization compared to the other treatments. In contrast The potassium oxalate group demonstrated the lowest sensitivity scores, suggesting superior and sustained relief. Notably, LLLT performed comparably to potassium oxalate, with significantly lower pain scores than the APF gel. These results indicate that while all treatments reduced hypersensitivity, potassium oxalate and LLLT were significantly more effective than APF gel in later stages (3rd and 4th weeks), particularly in response to cold stimuli.
This differential efficacy highlights the importance of stimulus- specific responses in evaluating DH treatments. While all three interventions achieved complete relief in the air blast test, potassium oxalate and LLLT provided better long-term desensitization against cold-induced pain, making them preferable for patients with persistent thermal sensitivity.

DISCUSSION

The present study demonstrate a comparison between three groups Low Level LASER, Postssium Oxalate gel and 1.23% APFgel used for dentinal hypersentivity. Dentinal hypersensitivity was checked based on two parameter first was the air blast test and the other was cold test. In the treatment protocol all the three groups followed their respective directed instructions. Reading was taken at baseline 1st, 2nd, 3rd, and 4th week.
In the current study at baseline, the comparison of VAS scores for the air blast test revealed no significant differences between the three groups, indicating that all groups had similar levels of sensitivity at the beginning of the study. Similarly, at each post- operative visit (1st – 4th week), the VAS scores for the air blast test remained comparable across the groups, with no statistically significant differences observed. The inter group comparison at baseline and during all subsequent time intervals consistently demonstrated a lack of significant differences in air blast sensitivity, highlighting uniformity in outcomes across the three groups throughout the study period.
Comparing intra group results of cold test among three groups, at baseline, there was no significant difference in the VAS scores for the cold test in all the three groups. Similarly, at the 1st and 2ndweek, no significant differences in VAS scores were observed. However, at the 3rd and 4th weeks, the highest VAS score was recorded in the 1.23% APF gel group, while the lowest score was observed in the potassium oxalate group. All three groups showed a significant difference between them at different time interval.
Intergroup comparison of cold test among the three groups shows that at baseline, there were no significant differences in the VAS scores for the cold test between the three groups. Similarly, at the 1st and 2nd weeks, the VAS scores did not differ significantly among the groups. However, at the 3rd and 4th weeks, the VAS score in the 1.23% APF gel group was significantly higher than those in the low-level laser group and the potassium oxalate group. Meanwhile, the VAS scores between low-level laser group and the potassium oxalate group showed no significant difference at 3rd and 4th week.
In the current study potassium oxalate group gave the best result, it may be due to the reason that potassium oxalate completely obliterate the dentinal tubules as concluded in the study by Pereiraet al27, and Santiago et al28, as it creates insoluble calcium oxalate crystals by interaction with calcium in the dentinal fluid causing obstruction of the tubules which reduces hypersensitivity29 Additionally, the persistence of oxalate precipitates is increased by their higher resistance to disintegration in acidic conditions.30 High potassium content of the topically applied oxalate solutions may raise the extracellular potassium concentration in surrounding deep dentinal nerves, depolarising them and reducing their excitability. This process may account for potassium oxalate's immediate short-term desensitising effects.31
Jose Carlos Pereira27conducted a study using scanning electron microscopy have demonstrated that topical administration of oxalates to dentin causes insoluble calcium oxalate crystals to precipitate on the dentin surface. According to hydrodynamic principles given by MartinBrannstorm32, the crystal deposition reduces fluid flow inside the dentin, which in turn reduces dentinal sensitivity.28,33 This may accounts for potassium oxalate used in the current study to have a significant contribution in reducing dentinal hypersenstivity than other groups.
Our finding is also in concurrence with a study by Paula Cesar Sgreccia23 having similar results i.e. potassium oxalate gel was better than low level laser therapy when used in non-carious cervical lesion cases. Dentinal hypersensitivity can also be treated with an alternative therapeutic option as the development of laser technology and its expanding use in dentistry has provided treatment option for dentinal hypersenstivity. Depending on its active medium, wavelength, and power density as well as the optical characteristics of the target tissue, the laser interacts with the tissue to produce various tissue responses.6
PandeyRatal21conducted a study which compared three groups 5% potassium nitrate (KNO_3) toothpaste, low-level laser therapy (LLLT), and LLLT with 5% KNO_3 toothpaste for the treatment of dentinal hypersensitivity (DH). The study concluded a greater reduction in DH at the end of 3 weeks in LLLT with 5% KNO_3 group and LLLT group when compared to 5% KNO_3 group. The reason for LLLT to be better in this study could be that they compared it with potassium nitrate in contrast with the current study as it is compared with potassium oxalate.
In this study 1.23% APF was chosen in this study, as it has the highest concentration of fluoride ions (12,300 ppm) among all the fluoride gels used in dentistry. It has been postulated that fluorides used in higher concentrations were more effective in treating dentinal hypersensitivity.34An in vitro study by Jayaram etalonextractedhumantoothitwasconcludedthatafter60sec application of APF gel could occlude dentinal tubules by 73.09%.34 Fluoride's primary method of relieving DHS is its chemical capacity to decrease and stop fluid flow in the dentin tubules by forming calcium-phosphorous precipitates, calcium fluoride (CaF_2), and fluorapatite (FAp).35
The reason for 1.23% APF gel group's VAS score was noticeably higher than that of the potassium oxalate gel and low level laser group, might be because 1.23% APF gel tends to occlude less dentinal tubules when used alone when compared to in conjunction with laser which was concluded in a study by Jayaram et al 34
All three treatment modalities demonstrated a statistically significant reduction in dentinal hypersensitivity over time, highlighting their potential in managing DH. However, the degree and speed of symptom relief varied among the modalities.

FIGURE 1- COLD TEST IN LOW LEVEL LASER THERAPY GROUP

FIGURE 2- AIR BLAST TEST IN LOW LEVEL LASER THERAPY GROUP

PHOTOGRAPHNO.3-LOWLEVELLASER THERAPY GROUP IRRIDIATION

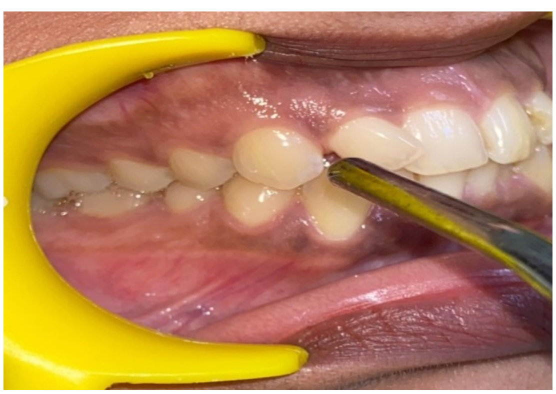


FIGURE 4- AIR BLAST TEST IN POTASSIUM OXALATE GEL GROUP

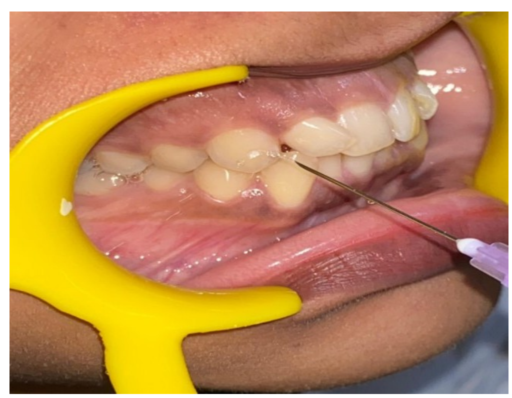


FIGURE 5- COLD TEST IN POTASSIUM OXALATE GEL GROUP

FIGURE 6- POTASSIUM OXALATE GEL APPLICATION

FIGURE 7- APPLICATION OF POTASSIUM OXALATE GELWITH MICROBRUSH

FIGURE 8- COLD TEST IN 1.23% ACIDULATED PHOSPHATE FLORIDE GEL

FIGURE 9-AIR BLAST TEST IN 1.23% ACIDULATED PHOSPHATE FLORIDE GEL

FIGURE 10- 1.23% ACIDULATED PHOSPHATE FLORIDE GEL APPLICATION

FIGURE 11- 1.23% ACIDULATED PHOSPHATE FLORIDE GEL APPLICATION

CONCLUSION:

This study was conducted to evaluate and compare the efficacy of low-level laser therapy (LLLT), potassium oxalate gel, and acidulated phosphate fluoride (APF) gel in the management of dentinal hypersensitivity (DH). Based on the results and observations, the following conclusions can be drawn:

1. **Efficacy of Treatment Modalities**:
   - All three treatment modalities demonstrated a statistically significant reduction in dentinal hypersensitivity over time, highlighting their potential in managing DH. However, the degree and speed of symptom relief varied among the modalities.
     - **Low-Level Laser Therapy (LLLT)**:
       - LLLT proved to be highly effective in reducing dentinal hypersensitivity, particularly in terms of immediate and sustained relief. Its mechanism involves sealing dentinal tubules through photobiomodulation, reducing nerve excitability, and promoting tissue repair, which collectively contribute to rapid and long-lasting desensitization.
       - LLLT also has the advantage of being a non-invasive and pain-free procedure, making it a favorable choice for patients with severe DH.
     - **Potassium Oxalate Gel**:
       - In the current study potassium oxalate gel demonstrated better efficacy in reducing DH than LLLT. Its mechanism involves the formation of calcium oxalate crystals within the dentinal tubules, blocking fluid movement and minimizing the sensitivity response.
     - **Acidulated Phosphate Fluoride (APF) Gel**:
       - APF gel showed the least efficacy among the three treatments. Although it works by precipitating calcium fluoride at the dentinal surface and within the tubules to block stimuli transmission, the relief provided was less immediate and less sustained.
       - Despite its limited performance, APF gel remains a viable option, particularly for patients with mild DH or as an adjunctive treatment.
2. **Clinical Implications**:
   - The choice of treatment for dentinal hypersensitivity should be based on the severity of the condition, patient preference, and the need for immediate versus long-term relief.
   - LLLT can be recommended for patients seeking rapid and durable results, particularly those who are unresponsive to conventional desensitizing agents.
   - Potassium oxalate gel is suitable for moderate cases of DH and offers a cost-effective alternative with satisfactory results.
   - APF gel can be considered for mild sensitivity or as a preventive measure in patients with a higher risk of DH.
3. **Advantages and Limitations**:
   - Each modality has its benefits and limitations, which should be considered in clinical practice. LLLT, while effective, may require specialized equipment and training, making it less accessible in certain settings.

Potassium oxalate and APF gels are more economical and easier to use but may not provide the same level of efficacy as LLLT.

4. **Future Recommendations**:
    - Further longitudinal studies with larger sample sizes and diverse populations are necessary to confirm the long-term effectiveness and safety of these modalities.
    - Combining these treatments or exploring synergistic approaches could potentially enhance outcomes for managing dentinal hypersensitivity.
    - Incorporating patient-reported outcomes, such as satisfaction and quality of life, can provide a more comprehensive understanding of treatment efficacy.

In conclusion, while all three treatment modalities are effective in reducing dentinal hypersensitivity, low-level laser therapy and potassium oxalate stands out as the most effective and reliable option, particularly for patients with severe or persistent DH.APF gels remain valuable alternatives, especially in resource- limited settings or for mild to moderate cases. Clinicians should tailor their approach to each patient's specific needs to achieve optimal outcomes.

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