Original Article

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Dentistry Section

Clinical Evaluation of Pro-Argin and Low Level Laser Therapy in the Treatment of Dentinal Hypersensitivity: A Split-mouth Randomised Clinical Trial

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ABSTRACT

Introduction: Dentinal Hypersensitivity (DH) is the most prevalent condition that causes patients discomfort for patients, leading them to frequently visit dental offices. A wide range of methods and therapeutic procedures have evolved for pain alleviation have evolved. In recent decades, desensitising therapy has been coupled with newer therapies such as Pro-Argin and Low-Level Laser Therapy (LLLT). Pro-Argin therapy occludes the openings of dentinal tubules, while Diode Lasers (DL) cause a melting effect, crystallisation of dentine inorganic components, and coagulation of fluids trapped inside the dentinal tubules, thereby reducing the hypersensitivity.

Aim: To compare the efficacy of Pro-Argin and LLLT -475 nm (Bluelase) in providing immediate relief in the treatment of dentinal hypersensitivity.

Materials and Methods: This was a double-blind randomised split-mouth clinical trial involving from December 2021 to March 2022, including 12 patients (120 teeth) with bilateral hypersensitivity. They were divided into Group A (Pro-Argin) and Group B (LLLT-475 nm) both with 12 patients and 60 teeth each. Hypersensitivity was recorded using the Schiff cold air sensitivity scale and the Visual Analog Pain Scale (VAS) at baseline and at 15 minutes after desensitising therapy.

Results: The study included 12 subjects with bilateral dentinal hypersensitivity, categorised into Group A (Pro-Argin) (Colgate Sensitive Pro-relief) and Group B (LLLT at 475 nm), with 60 teeth each. The Results were assessed using the independent t-test for inter-group comparison and the t-test for intra-group comparison. On inter-group comparison of the Schiff cold air sensitivity score, there was a statistically significant reduction in dentinal hypersensitivity in both the groups ($p<0.001$) with no statistical significance in VAS scores. However, on intra-group comparison; there was a statistically significant reduction in VAS scores in Group B ($p\leq0.001$).

Conclusion: LLLT has provided a significant reduction in dentinal hypersensitivity when compared with Pro-Argin.

Keywords: Desensitisation, Diode lasers, Visual analogue pain scale

INTRODUCTION

The DH is a "short, acute discomfort resulting from exposed dentin in reaction to stimuli" [1]. Canines and first premolars are the most affected, followed by incisors and second premolars, and finally molars. The buccal surface of the teeth is most commonly affected. It worsens between the ages of 20 and 30, then again in the 50s [2]. Although the prevalence of DH ranges from 4 to 57% in healthy people, it has been observed to be between 60 and 98% in those with periodontitis [3]. Females tend to experience it more than males, owing to greater general healthcare and dental hygiene knowledge. Cold is the most prevalent source of discomfort in individuals with dentinal hypersensitivity [3,4].

According to Brännström's hydrodynamic hypothesis, mechanical displacement of nerve terminals at the pulp/dentin interface creates a painful sensation [5]. There are two unique therapeutic strategies i.e., nerve impulse suppression by direct neurological contact or mechanical blockage of dentinal tubules. The latter is the most essential therapeutic strategy in the treatment of dentinal hypersensitivity [2]. Desensitising agents and lasers are being widely used to treat the hypersensitivity [6]. DH is a highly subjective perception, and there is no "gold standard" for assessing the treatment outcomes.

Orchardson and Gillam have shown that DH mostly affects the vestibule-cervical region of teeth. Cervical DH most likely has a complex aetiology, and its painful manifestation is caused by multiple factors. Therefore, numerous therapies must be combined to reduce DH to acceptable levels [7]. Lasers have been used to complement desensitising chemical treatments by generating changes in the neural transmission network within the tooth pulp, rather than the visible dentin surface as seen in most therapies. The formation of secondary dentin, which allows for physiological occlusion of the dentinal tubules and stimulation of endorphin release from nerve terminal synapses located in the dentinal tubules, is also a bio-stimulating effect [8].

The Erbium-doped Yttrium Aluminium Garnet (Er:YAG), Neodymium-doped Yttrium Aluminium Garnet (Nd:YAG), Carbon Dioxide (CO_2) and Digital Laser Source (DLS are among those employed [6]. There is an extraordinary efficacy in using DLs in the treatment of dentinal hypersensitivity among the published works. Until now, DLs with wavelengths of 810, 940, and 980 nm have been used to treat dentinal hypersensitivity [9]. A new potential in the realm of medicine and dentistry, a DL device generating blue light was introduced as a potential innovation in the field of medicine and dentistry. This Bluelase system has several advantages, including high working efficacy at low power levels and a low depth of light absorption at 475 nm, which causes less harm to the pulpal tissues [10].

At physiological pH, arginine and calcium carbonate interact and bind to the negatively charged dentine surface to form a calcium-rich layer, according to the most current Pro-Argin Technology research. This causes dentin tubules to become blocked, which remains intact even after acid exposure, preventing the transmission of pain-producing sensations [11]. As a result, several regimens have been

explored and evaluated in order to provide the optimal therapeutic benefit.

There is a dearth of evidence comparing desensitising paste to DL 475 nm (Bluelase) in delivering immediate relief from dentinal hypersensitivity. The purpose of the present study was to determine the effectiveness of desensitising toothpaste containing Pro-Argin and LLLT-475 nm (Bluelase) in providing immediate alleviation of dentinal hypersensitivity.

MATERIALS AND METHODS

This was a double-blinded, split-mouth randomised clinical trial, conducted in the Department of Periodontology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India, from December 2021 to March 2022. The study received Institutional Ethics Committee approval (VDC/IEC/2021/UG01/PI/IVV/56) and was registered in Clinical Trials Registry India (CTRI/2021/09/036746). The study was conducted in accordance with the guidelines of the Declaration of Helsinki.

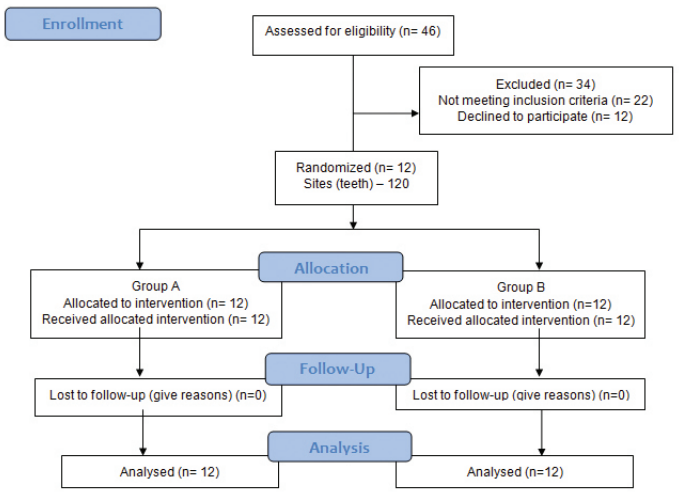
Inclusion criteria: Systemically healthy subjects aged rage between 32-60 with a complaint of dentinal hypersensitivity and history of no previous use of desensitising agents were included.

Exclusion criteria: Patients with any carious lesions, cracked teeth, or those using analgesics/anti-inflammatory medications at the time of the study were excluded.

Sample size calculation: The sample size was calculated using G-Power 3.1 software, with an effect size of 0.94, and an α-value of 0.05, and a desired power of 0.80. The estimated sample size was 10 patients. Considering a 20% loss of follow-up, 12 patients were included in the study [6].

Procedure

A total of 46 patients of hypersensitivity were assessed for inclusion in the study and councelled regarding the treatment procedure. After discussing the treatment procedure, the participants provided a written informed consent. Finally, study included 12 subjects with bilateral dentinal hypersensitivity, who were divide into Group A (Pro-Argin) (Colgate Sensitive Pro-relief) and Group B (LLLT at 475 nm) with 60 teeth (5-6 teeth in each group). Only teeth with dentinal hypersensitivity were randomly assigned using a simple coin toss method and received the respective treatment. All the subjects had received oral prophylaxis before the desensitising therapy [Table/Fig-1].



[Table/Fig-1]: CONSORTs flow chart.

Evaluation of dentinal hypersensitivity: Prior to the evaluation, the surrounding teeth were isolated with cotton, except for the test tooth/teeth, to prevent false-positive results. Dentinal hypersensitivity was measured in both groups using evaporative stimuli. This was done accomplished by directing an air syringe at a right angle to the exposed affected tooth site, at a distance of 1-3 mm from the exposed dentin surface [5]. The subjective perception of the patients was assessed using the Schiff cold air sensitivity scale [12] and a Visual Analog Scale (VAS) score before and after the desensitising treatment.

Recording the parameters: After the oral prophylaxis, baseline hypersensitivity scores were recorded. Group A received the desensitising agent with a fingertip application by one examiner directly on the buccal cervical surface of the hypersensitive tooth, followed by rinsing with water after 5 minutes [Table/Fig-2]. Similarly, Group B received a LLLT (475 nm), a frequency of 15 Hz, and a power of 0.7 W in a continuous mode for one minute on the hypersensitive tooth surfaces [6] [Table/Fig-3]. Post-treatment hypersensitivity scores (Schiff cold air and VAS) were recorded in both the groups after 15 minutes.

[Table/Fig-2]: Professionally applied Pro Argin desensitising tootpaste.
[Table/Fig-3]: Application of diode laser 475 nm (Bluelase). (Images from left to right)

Instructions on oral hygiene were provided. Patients were instructed to use a soft-bristled toothbrush with desensitising toothpaste twice a day for three minutes and to brush using the modified bass method.

STATISTICAL ANALYSIS

The acquired data were statistically analysed using Statistical Package for Social Sciences (SPSS) version 21.0. Descriptive statistics were expressed as mean±standard deviation. The results were statistically assessed using the independent t-test for intergroup comparison and the paired t-test for intragroup comparison. A p-value of <0.05 was considered statistically significant, and a p-value of <0.001 was considered statistically highly significant.

RESULTS

Out of 46 subjects screened 12 patients (7 males and 5 females) were included in the study based on inclusion and exclusion criteria mentioned. The mean age of the patients was 45±3 years. No adverse effects were observed in any of the cases during the study.

In intra-group comparison, the mean score of the Schiff cold air blast test was 2.80±0.40 at baseline and 1.40±0.49 after 15 minutes of therapy in Group A (p<0.001). In Group B, the mean score was 2.53±0.50 at baseline and 0.86±0.34 after 15 minutes of therapy (p<0.001). Both groups showed highly significant improvement [Table/Fig-4].

Schiff cold air blast test		Mean	SD	p-value
Group A	Baseline	2.80	0.40	<0.001**
	15 min post-therapy	1.40	0.49	
Group B	Baseline	2.53	0.50	<0.001**
	15 min post-therapy	0.86	0.34	

[Table/Fig-4]: Intragroup comparison of Schiff cold air blast test in Group A and Group B at baseline and 15 minutes after therapy.
**p≤0.001- highly significant

In intergroup comparison, the baseline mean score of the Schiff cold air blast test for Group A and Group B was 2.80±0.40 and 2.53±0.50, respectively, with no statistical significance (p=0.069). After 15 minutes of therapy, the scores were 1.40±0.49 for Group A and 0.86±0.34 for Group B, and the difference was statistically highly significant (p<0.001) [Table/Fig-5].

In intragroup comparison, the VAS mean score was 8.33±0.80 at baseline and 5.00±1.43 after 15 minutes of therapy in Group A (p<0.001). In Group B, the mean score was 8.50±0.62 at baseline and 1.13±1.43 after 15 minutes of therapy (p<0.001). Both groups showed highly significant improvement [Table/Fig-6].

Parameters	Type (Schiff cold air blast test)	Mean	SD	p-value
Baseline	Group A	2.80	0.40	0.069
	Group B	2.53	0.50	
15 min Post Therapy	Group A	1.40	0.49	**<0.001****
	Group B	0.86	0.34	

[Table/Fig-5]: Intergroup comparison of Schiff cold air blast score in Group A and Group B at baseline and 15 minutes after therapy.
**p≤0.001- highly significant

VAS score		Mean	SD	p-value
Group A	Baseline	8.33	0.80	**<0.001****
	15 min post-therapy	5.00	1.43	
Group B	Baseline	8.50	0.62	**<0.001****
	15 min post-therapy	1.13	1.43	

[Table/Fig-6]: Intragroup comparison of Visual Analog Scale (VAS) score in Group A and Group B at baseline and 15 minutes after therapy.
**p≤0.001- highly significant

In intergroup comparison, the baseline VAS mean score for Group A and Group B was 8.33±0.80 and 8.50±0.62, respectively, with no statistical significance (p=0.374). After 15 minutes of therapy, the scores were 5.00±1.43 for Group A and 1.13±1.43 for Group B, and the difference was statistically highly significant (p<0.001) [Table/Fig-7].

Parameters	Type (VAS)	Mean	SD	p-value
Baseline	Group A	8.33	0.80	0.374
	Group B	8.50	0.62	
15 min. Post Therapy	Group A	5.00	1.43	**<0.001****
	Group B	1.13	1.43	

[Table/Fig-7]: Intergroup comparison of Visual Analog Scale (VAS) score in Group A and Group B at baseline and 15 minutes after therapy.
**p≤0.001- highly significant

DISCUSSION

In the present study, the effectiveness of desensitising toothpaste containing Pro-Argin and LLLT in reducing dentinal hypersensitivity instantaneously was observed. Although both Pro-Argin and low-level laser are beneficial in decreasing dentinal hypersensitivity, low-level lasers are more effective at the investigated time intervals.

Desensitising treatments can be performed at home by the patient using dentifrice or professionally by a dentist using in-office topical desensitising compounds or lasers [11]. Various agents such as protein precipitants (formaldehyde and silver nitrate), tubule occluding agents (sodium fluoride, stannous fluoride, calcium hydroxide, and potassium nitrate), tubule sealants (resins and adhesives), and lasers are commonly used [6]. While both methods are effective in reducing hypersensitivity, the duration of relief can vary greatly. To address the need for materials that chemically interact with the tooth surface to diminish dentinal hypersensitivity, novel technologies like Pro-Argin technology have been developed [2].

According to Kleinberg I et al., Pro-Argin physically adsorbs onto the surface of calcium carbonate, resulting in a positively charged agglomeration. This agglomeration adheres to the dentinal surface and tubules [13]. Additionally, the pH of this agglomeration is alkaline, allowing for calcium and phosphate mineral deposition on the dentinal surface. The immediate relief provided by Pro-Argin technology is a significant advantage. Lavender SA et al., demonstrated through Confocal Laser Scanning Microscopy (CLSM) and high-resolution Scanning Electron Microscopy (SEM) images that arginine calcium carbonate is highly effective in occluding open dentin tubules and that the occlusion achieved is resistant to acid challenge, resulting in immediate relief [14].

In the present study, the VAS score was used to assess subjective perception [15,16]. Both the Schiff cold air blast test and the VAS scale showed a reduction in sensitivity, with a highly significant difference between the groups. These findings are consistent with Ines Kapferer's study, which found that a dentifrice containing 8% arginine and calcium carbonate reduced hypersensitivity [17]. Pro-Argin dentifrice, when applied to sensitive teeth after scaling and root planing, has been shown to provide instant sensitivity relief [18,19]. Various Pro-Argin trials have resulted in dentinal tubule occlusion, reduced permeability, and improved oral health-related quality of life [19-21].

LLLT produces alterations inside the nerve transmission network of the tooth pulp rather than directly impacting the exposed dentinal surface. This specific wavelength affects the cell membrane, allowing for increased passage of Ca^{2+}, Na^{2+}, and K^{+} ions. As a result, the endorphin system and neural cell action potentials increase, while C fiber afferent depolarisation is suppressed, preventing pain information from reaching the central nervous system. Nd:YAG, Er,Cr:YSGG, and CO2 lasers, on the other hand, can melt peritubular dentin and partially or completely occlude dentinal tubules, providing relief from hypersensitivity symptoms in patients [11].

In the current study, the use of low-level lasers resulted in immediate alleviation of hypersensitivity as measured by the Schiff cold air blast test and the VAS score. When comparing a desensitising dentifrice with low-level laser desensitisation, a decrease in sensitivity was observed, consistent with numerous previous studies that evaluated the same and achieved similar results [6,11]. Similarly, after non-surgical periodontal treatment with lasers (685 nm and 660 nm) on exposed dentinal tubules, an immediate decline in dentinal hypersensitivity was observed, with long-term therapeutic benefits for teeth with gingival recession [22,23].

In clinical investigations, Garcia-Delaney C et al., Bal MV et al., Hashim NT et al., Tabatabaei MH et al., reported that low-level lasers were effective in providing immediate relief from hypersensitivity [23-26]. Silicia A et al., investigated the immediate effectiveness of an 810 nm low-level laser and a 10% potassium nitrate bioadhesive gel (NK10%) in reducing dentinal hypersensitivity. Observations revealed a reduction in hypersensitivity of 36.9% (0.86) following an Evaporative Stimulus (ES) after 15 minutes, which was three times greater than the control group (0.23). The results observed were comparable to those found in our study [27].

In the present study, although Pro-Argin and LLLT showed reduction in dentinal hypersensitivity, LLLT provided immediate relief. This is in accordance with studies by Pandey R et al., and Shan Z et al., where LLLT demonstrated greater and more positive immediate, interim, and persistent reduction in dentinal hypersensitivity [28,29].

Srivastava S et al., reported in their study that 8% arginine and calcium carbonate significantly occluded dentinal tubules, but when used in conjunction with low-level laser therapy, it was found to be more effective in reducing hypersensitivity, which is similar to the results obtained in the present study [30].

Limitation(s)

In the present study, the long-term and persistent effects of Pro-Argin and LLLT in providing desensitisation were not evaluated.

CONCLUSION(S)

Based on the results of this clinical study, it can be inferred that while both Pro-Argin and low-level laser are effective in reducing dentinal hypersensitivity, low-level lasers are more successful in providing immediate relief.

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