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Original Article

Dentistry Section

Crown Lengthening by Conventional Diode Laser and Blue Laser: A Randomised Clinical Trial

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ABSTRACT

Introduction: Crown lengthening is a reliable procedure that enables the restoration of teeth with a short clinical crown, extensive subgingival caries, and correction of excessive gingival display for aesthetic purposes. Blue laser, a recent technology in dentistry, has shown significant effectiveness at low power settings, promoting favourable wound healing effects.

Aim: To compare the Visual Analogue Scale (VAS) scores and wound healing outcomes between blue laser and denlase in performing crown lengthening procedures.

Materials and Methods: A randomised clinical trial was conducted in the Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India, involving 14 patients who were divided into two groups. Participants were recruited from September 2021 to April 2022. Ethical clearance was obtained from the Institutional Ethics and Review Board. Group-A underwent crown lengthening using blue laser (445 nm), while Group-B received treatment with denlase (980 nm). VAS scores and the wound healing index were recorded and compared between the two groups at baseline, 10 days, and one month after the surgery. Statistical tests such as the Mann-Whitney U test, unpaired t-test, and repeated measures ANOVA were used for analysis.

Results: The study revealed a statistically significant difference (p-value=0.006) in VAS scores between the blue laser group (mean value of 0.5) and the denlase group (mean value of 1.3). However, statistically significant differences in Wachtel's early wound healing index were not observed in either of the groups.

Conclusion: Blue laser treatment was found to be more comfortable for patients, as indicated by the lower VAS scores. Both groups demonstrated good wound healing properties based on Wachtel's early wound healing index, with no significant difference between them. It is important to note that literature on blue laser technology is still in its early stages and requires further comprehensive investigation.

Keywords: Aesthetics, Biological width, Wound healing

INTRODUCTION

Addressing the biological, functional, and aesthetic requirements of the tooth to be treated is the prime concern of every clinician. An adequate understanding of the relationship between periodontal diseases and restorative dentistry is of paramount importance, not only to ensure adequate form and function, but also to enhance periodontal aesthetics. Periodontal health is the cornerstone of any successful restorative procedure, and the encroachment of the biological width becomes a particular concern when considering tooth restoration. Violation of the biological width, in its true sense, means placing a restorative margin in the connective tissue attachment [1]. The concept of biological width also has considerations pertaining to endodontic and prosthodontic disciplines [2].

Crown lengthening is one of the commonly advocated procedures performed to ensure the preservation of biological width. It is a reliable procedure that enables the restoration of teeth with a short clinical crown, extensive subgingival caries, and subgingival tooth fractures at the dentogingival junction [3]. The concept of crown lengthening was first introduced by Cohen WD in 1962 [4].

To date, several surgical techniques have been proposed for crown lengthening, such as gingivectomy, apically displaced flap with or without resective osseous surgery, and surgical extrusion using a periotome [5]. The selection of one technique over another depends on several patient-related factors, such as aesthetics, clinical crown-to-root ratio, root proximity, root morphology, furcation location, individual tooth location, collective tooth position, and the ability to restore the teeth [6]. Hence, careful treatment planning is a prime requisite that needs to be advocated by a clinician to preserve periodontal health.

Lasers have been one of the best modalities available, with a wide range of applications, and have undoubtedly become many clinicians' favourites. They offer numerous beneficial factors compared to scalpel surgical procedures, including greater precision, a bloodless surgical field, no need for suturing, and minimal postoperative swelling or scarring [7]. As a result, the level of patient satisfaction and the achieved treatment outcomes are remarkable [7].

Lasers of varying wavelengths are being used for an array of surgical procedures, and the blue diode laser system (445 nm) has emerged as a recent implication in the field of dentistry. This blue laser system provides several advantages compared to the established diode laser system. Some of these advantages include high working effectiveness at low power settings and a favorable effect on wound healing [8]. Interestingly, the antimicrobial effects are quite high, facilitating effective disinfection of contaminated tissue areas [9].

The absorption of light at 445 nm in water is low. Therefore, during surgical procedures, radiation energy is almost completely transmitted through the mucin layer, allowing the cutting procedure to start immediately without the need for the initial incision required by diode lasers [9]. Clinical studies conducted so far have primarily consisted of case reports or case series using the 450 nm diode laser, and none of them have compared it with the 980 nm diode laser in terms of patient and clinical perspectives [4,7]. However, to date, not a single study on the utility of the blue laser in crown lengthening has been available. Therefore, the present clinical study aimed to evaluate patient perceptions VAS and wound healing properties (Wachtel's early wound healing index) of the blue laser compared to denlase. This study aimed to compare the novel blue laser (445 nm) with the well-established denlase (980 nm) in performing crown lengthening procedures.

MATERIALS AND METHODS

This randomised clinical trial (CTRI/2021/08/035561) was conducted in the Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India. Participants were recruited from September 2021 to April 2022. Ethical clearance was obtained from the Institutional Ethics and Review Board, and informed consent was obtained from the patients (IECVDC/20/PG01/PI/IVV/07).

Sample size calculation: Sample size calculation was performed using G*power software version 3.1.0 for crown lengthening as the primary outcome, based on estimates from a pilot study. The calculations were based on an effect size of 0.628, a 95% confidence level, and 80% power. The estimated sample size was 20 sites. Considering a 15% loss of follow-up, a total of 24 sites were included in the study. A total of 14 patients (24 teeth) with age groups ranging from 20 to 50 years, who required crown lengthening for one or more teeth to gain retention in sites with insufficient supracrestal tooth structure or for aesthetic crown lengthening in cases of excessive gingival display, were enrolled in this study.

Inclusion criteria:

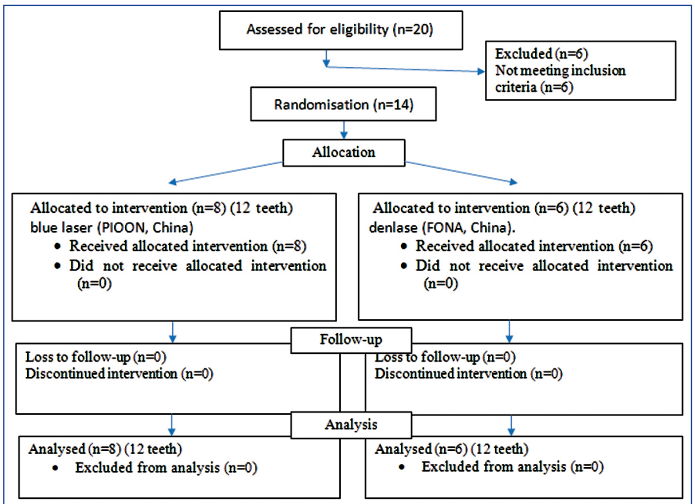
- Periodontally healthy patients requiring crown lengthening for restoration of either anterior or posterior teeth.
- Patients with excess gingival display or short clinical crowns.

Exclusion criteria:

- Patients with systemic diseases that contraindicate periodontal surgery, such as uncontrolled diabetes.
- Patients with active gingival and periodontal diseases.
- Smokers.

In this double-blinded study, the patients were randomly allocated into two groups using the coin toss method:

- Group-A included eight patients with 12 teeth requiring crown lengthening, which was performed with the blue laser (445 nm) (PIOON, China).
- Group-B included six patients with 12 teeth requiring crown lengthening, which was performed with the denlase (980 nm) (FONA, China) [Table/Fig-1].



[Table/Fig-1]: CONSORT flowchart.

All subjects received initial treatment of oral prophylaxis and oral hygiene instructions. Upper and lower impressions were taken, and models were prepared. Prior to surgery, a customised acrylic stent was prepared, involving at least two teeth adjacent to the tooth to be treated. These grooves were of sufficient length to aid in guiding a calibrated periodontal probe (UNC 15 probe) for repeated reproducible measurements. The need for crown lengthening was assessed by measuring the clinical crown length using the UNC 15 probe along these grooves. The amount of gingiva to be excised was determined based on the requirement and the biologic width. Local infiltration (2% lignocaine, 1:80,000) was administered preoperatively to all patients, and crown lengthening was performed using the blue laser (1W) or the denlase (3W) for the respective groups of patients. Analgesics (Diclofenac sodium 50 mg) were prescribed postoperatively, and VAS scores were recorded by the examiner before the administration of analgesics.

The primary parameters considered in this study were patients' comfort using the VAS score [10] and wound healing using Wachtel's early wound healing index [11] following the laser treatments in their respective groups.

Wachtel's early wound healing index:

- Score-1: Complete flap closure, no fibrin line in the interproximal area.
- Score-2: Complete flap closure, fine fibrin line in the interproximal area.
- Score-3: Complete flap closure, fibrin clot in the interproximal area.
- Score-4: Incomplete flap closure, partial necrosis of the interproximal tissue.
- Score-5: Complete necrosis of the interproximal tissue.

The periodontal parameters, such as Plaque Index (PI) [12], Gingival Index (GI) [12], position of the gingival margin (measured from a reference point on the stent to the free gingival margin) [13], clinical attachment level (measured from a reference point on the stent to the base of the pocket) [13], probing pocket depth (measured by subtracting the position of the gingival margin from the clinical attachment level) [13], and biologic width [13] were measured by subtracting the clinical attachment level from the bone level.

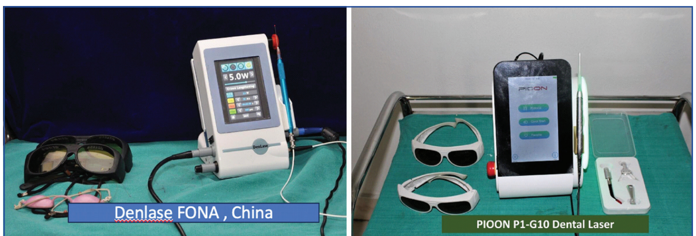
The primary parameters, such as the VAS score, were assessed one hour after surgery, and Wachtel's early wound healing index was recorded at ten days and one month after surgery. The secondary parameters were recorded before starting the treatment, as well as 10 days and one month after the treatment. All parameters were recorded by one examiner.

STATISTICAL ANALYSIS

The data were subjected to normality tests before checking for differences in the study parameters between the groups. The choice of statistical tests was made based on the results obtained from the Mann-Whitney U test, unpaired t-test, and repeated measures ANOVA using Statistical Package for Social Sciences (SPSS) software version 25.0.

RESULTS

A total of 14 patients, including nine males and five females, with a mean age of 35.78±11.23 years, were included in the current study. Among them, eight patients (12 teeth) requiring crown lengthening were treated with a blue laser, while the other group of six patients (12 teeth) were treated using denlase. [Table/Fig-2,3] summarises the intergroup comparison of mean VAS scores. This study showed a statistically significant difference (p=0.006) in VAS scores between the blue laser group and the denlase group, with a mean value of 0.5±0.13 in the blue laser group and 1.3±0.38 in the denlase group.



[Table/Fig-2]: Images of laser systems used.

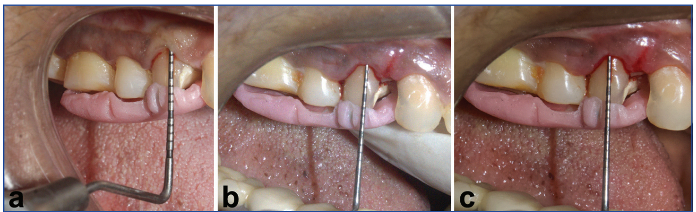
Statistical parameter	Blue laser	Denlase	p-value
Mean VAS	0.5±0.13	1.3±0.38	0.006

[Table/Fig-3]: Comparison of VAS between blue laser and denlase (an hour after the treatment).
*VAS: Visual analogue scale; test applied: Mann-Whitney U test; p-value: Probability value; p-value less than 0.05 is considered statistically significant

Wachtel's early wound healing index was recorded at ten days and one month after the crown lengthening procedure, as tabulated in [Table/Fig-4]. The scores were not statistically significant for both groups (p=0.976). All the patients showed reasonably good healing of soft tissue at ten days and one month of treatment, as depicted in [Table/Fig-5,6]. Within both the blue laser group and the denlase group, a statistically significant difference was observed from baseline to one month with respect to probing depths (p<0.001), as shown in [Table/Fig-7] (mean values of 3.83±0.93, 2.33±0.49, and 2.41±0.51, respectively). However, both groups had comparable probing depths at each time point (p>0.05). Clinical attachment levels and bone remained the same from baseline to one month with no statistical significance between the groups (p>0.05) [Table/Fig-8].

Study group	10 days	1 month	p-value
Blue laser	1	1	0.976
Denlase	1	1	

[Table/Fig-4]: Comparison of Wachtel's early wound healing index between blue laser and denlase.
Test applied: Fisher's exact test, p-value less than 0.05 is considered statistically significant



[Table/Fig-5]: a) Preoperative view; b) immediate postoperative image of crown lengthening done using Denlase; c) postoperative view

[Table/Fig-6]: a) preoperative view; b) immediate postoperative image of crown lengthening done using Bluelaser; c) postoperative view.

Study group	Baseline	10 days	1 month	p-value#
Blue laser	3.83±0.93	2.33±0.49	2.41±0.51	<0.001
Denlase	3.96±0.79	2.50±0.52	2.58±0.51	<0.001
p-value*	0.794	0.509	0.509	

[Table/Fig-7]: Probing depths between blue laser and denlase groups.
Test applied: #Repeated measures of ANOVA and *Unpaired t test; p-value less than 0.05 is considered statistically significant

	Study group	Baseline	10 days	1 month	p-value#
CAL	Blue laser	4.75±0.75	4.75±0.75	4.75±0.75	1
	Denlase	4.58±0.66	4.58±0.66	4.58±0.66	1
	p-value*	0.645	0.645	0.645	
Bone level	Blue laser	2.34±1.25	2.34±1.25	2.34±1.25	1
	Denlase	2.26±1.56	2.26±1.56	2.26±1.56	1
	p-value*	0.902	0.902	0.902	

[Table/Fig-8]: Clinical Attachment Levels (CAL) and bone level between blue laser and denlase groups.
Test applied: #Repeated measures of ANOVA and *Unpaired t test; p-value less than 0.05 is considered statistically significant

The mean PI and GI gradually significantly reduced from baseline to one month in both groups (p<0.05). On intergroup comparison, there was no statistical significance, as shown in [Table/Fig-9]. Position of the gingival margin gradually increased in both groups with statistically significant p-value of 0.004 and 0.003 in the denlase and blue laser groups, respectively [Table/Fig-10]. Biologic width did not show any significant change in the blue laser group from baseline to one month (p=0.438) [Table/Fig-11].

	Study group	Baseline	10 days	1 month	p-value#
PI	Blue laser	1.17±0.42	1.02±0.68	0.98±0.38	0.042
	Denlase	1.09±0.31	0.97±0.56	0.83±0.64	0.038
	p-value*	0.729	0.762	0.648	
GI	Blue laser	0.79±0.41	0.61±0.23	0.45±0.36	0.018
	Denlase	0.86±0.41	0.78±0.53	0.59±0.27	0.025
	p-value*	0.826	0.725	0.625	

[Table/Fig-9]: PI and GI between blue laser and denlase groups.
Test applied: #Repeated measures of ANOVA and *Unpaired t test; p-value less than 0.05 is considered statistically significant

Study group	Baseline	10 days	1 month	p-value#
Blue laser	6.73±1.12	7.21±1.16	7.58±1.39	0.003
Denlase	6.49±1.82	7.25±1.15	7.32±0.92	0.004
p-value*	0.149	0.284	0.166	

[Table/Fig-10]: Position of gingival margin.
Test applied: #Repeated measures of ANOVA and *Unpaired t test; p-value less than 0.05 is considered statistically significant

Study group	Baseline	10 days	1 month	p-value#
Blue laser	1.12±0.31	1.09±1.19	1.19±0.32	0.438
Denlase	1.46±0.39	1.32±0.37	1.52±0.40	0.0258
p-value*	0.160	0.028	0.011	

[Table/Fig-11]: Biologic width.
Test applied: #Repeated measures of ANOVA and *Unpaired t test; p-value less than 0.05 is considered statistically significant

DISCUSSION

The blue laser has been well-established due to its unique absorption phenomenon in haemoglobin and melanin, thereby enhancing its ability for coagulation with a limited depth of penetration during incisions. Numerous studies in the literature advocate for the use of diode lasers in surgical crown lengthening procedures. However, to date, not a single study on the utility of the blue laser in crown lengthening has been available [8,14].

Therefore, the present clinical study was conducted to evaluate patient perceptions and wound healing properties of the blue laser compared to denlase for functional/restorative soft-tissue crown lengthening. The study focused primarily on patient comfort and wound healing, aiming to provide strong evidence that the lower wavelength blue laser exhibits less discomfort than denlase.

This study could prove this claim by showing a statistically significant difference in VAS scores between the blue laser group and the denlase group. Due to the shallower penetration offered by the blue laser [15], better wound healing is expected compared to the deeper penetration caused by the longer wavelength of denlase. Considering Wachtel's early wound healing index, no significant difference was observed between the groups, indicating that neither group proved to be better than the other after ten days and one month. This can be attributed to the minimal trauma and excellent healing properties demonstrated by diode lasers. The present study's findings are consistent with a study conducted by Frentzen M et al., where better cutting efficiency was found with a 445 nm laser compared to a 980 nm laser. The authors suggested that modifying the wavelength could improve the clinical relevance of incisions, excisions, or disinfection [8].

Another study by Gobbo M et al., compared the use of blue diode laser with two traditional surgical techniques, namely the infrared diode laser and the quantic molecular resonance scalpel, in the excision of benign oral lesions [15]. The blue diode laser group exhibited minimal bleeding and the lowest thermal tissue damage, which correlates with the current study where good wound healing was achieved with less patient discomfort in the blue laser group [15].

In a study by Braun A et al., histological evaluation was performed on tissue samples after incisions with a 445 nm laser, a 970 nm diode laser, and high-frequency surgery [16]. It was concluded that the 445 nm laser had higher cutting efficiency compared to the 970 nm laser and high-frequency surgery. However, these results cannot be generalised, and more studies on the blue laser need to be conducted and documented in the literature to provide better clinical evidence.

Limitation(s)

Histological examinations may be required to further confirm the wound healing properties of the blue laser, which were not conducted in this study.

CONCLUSION(S)

The blue laser, being a modified version of diode lasers, has proven to provide more comfort to patients, as indicated by the estimation of VAS scores. This may be attributed to its excellent working effectiveness at considerably lower power settings. The Wachtel's early wound healing index recorded in both groups demonstrated good healing properties without any difference between the groups. The blue laser appears to be a promising technology for clinical applications, as we observed excellent healing of soft tissue and minimal postoperative discomfort even with low power settings.

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