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Original Article

Intrabony defect management with a bone graft (hydroxyapatite and β-tricalcium phosphate) alone and in combination with a diode laser: A randomized control trial

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Abstract

Objectives: The current research was conducted to evaluate the use of a diode laser and a bone graft (hydroxyapatite [HA] + β-tricalcium phosphate [β-TCP]) in healing of intrabony defects. **Materials and Methods:** In this split-mouth evaluation, 40 patients with bilateral intrabony defects were treated with, Group I (control) - bone graft alone (HA + β-TCP) and Group II, (test) - bone graft with a diode laser. The clinical and radiologic parameters of all patients, such as plaque index (PI), probing depth (PD), gingival index (GI), gingival recession (GR), and relative clinical attachment level (RCAL) were recorded at baseline, after 3 months and after 6 months. **Results:** Reductions in PI, PD, GI, GR, and RCAL were found after 6 months. Furthermore, significant differences were displayed in the intra-group comparison while those of the inter-group evaluation ($P > 0.05$) were insignificant. **Conclusion:** In both groups, considerable decrease in intrabony pockets was discovered; however, the inter-group comparison was insignificant in relation to GR and RCAL.

Keywords: *Defects, Diode laser, Intrabony, Probing-pocket depth, Recession*

Introduction

Intrabony defects are quite common and depending on the number of remaining bony walls, which can be one, two or three-wall defect [1-3]. Periodontal therapy's main goal is to regenerate lost periodontal tissue, and its role is to control the periodontal disease process by reducing infection and inflammation, to improve esthetics, the health and function of the gingiva, the alveolar bone, the cementum, and the periodontal ligament [1].

Bacteria present in the intrabony pocket, which lowers the success rates by interfering with the regeneration process and the healing of osseous defects must be eliminated when treating intrabony defects using graft materials. However, these bacteria cannot be eradicated by mechanical therapy alone [4].

Both alone and in combination, numerous materials, such as allografts, xenografts, autogenous grafts, and alloplasts, have proven beneficial in periodontal osseous defect management [2]. Periodontal intrabony defects have been

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filled using porous hydroxyapatite (HA) bone graft material, as its exceptional bone conductive properties allow osteogenic cells to proliferate. A form of periodontal regenerative therapy that involves the combined use of porous HA, tricalcium phosphate (TCP), and platelet-rich plasma (PRP) offers a treatment option for periodontal intrabony defects [3].

Frequently, periodontitis is treated with laser technology. To improve periodontal tissue healing, it has been used to eliminate the bacteria and pocket lining as well as to remove endotoxins and calculus in the treatment of peri-implantitis and periodontitis [4]. Several studies have shown that, compared to scaling and root planning (SRP), diode lasers are a superior form of osseous defect management [5-8].

In relation to the surgical management of intrabony defects, there is limited research regarding the effectiveness of combining lasers with grafting materials. In consideration of this, the current research aimed to assess posttreatment intrabony defect healing with a diode laser and bone graft combination.

Materials and Methods

Study design

After obtaining approval from the Institutional Ethics Committee of the People's Dental Academy (IEC Ref No. PDA/Dean/2017/754-04), written informed consent was attained from the patients and the current research was conducted in the department of periodontics. This split-mouth research was conducted from April 2017 to November 2019 and involved 40 patients (male and female) with bilateral intrabony defects. Any one side of quadrant in same patient was randomly distributed as, test and control groups. An intrabony defect is an osseous fault with a greater depth than 2 mm and three bony walls surrounding the most apical portion.

Sample size selection

The sample size was estimated using the following power calculations and effect size: At least 37 sites per arm to achieve 80% power and a two-sided alpha level of 0.05 and 1 mm of pocket depth to detect effect size reduction. To account for potential dropouts, it was decided that a minimum of 40 patients would be enrolled in the trial.

Inclusion criteria

The current research included healthy participants between the ages of 35 and 60 years. They were not taking any antibiotics and possessed good oral hygiene (defined as a whole-mouth plaque index [PI]), pockets deeper than 6 mm after the initial therapy, and contralateral radiographic intrabony defects.

Exclusion criteria

Patients who were over 60 years, medically compromised or did not give consent were excluded from the research.

Procedure

The current study used nonsurgical periodontal therapy and recorded the demographic profiles of all subjects (name, gender, age, etc.). The plaque index (PI) (Loe, H 1967) and Gingival index (GI) (Silness and Loe, 1963) [10] were noted. Site-specific measurements were used for probing depth (PD), gingival recession (GR), and relative clinical attachment level (RCAL). Furthermore, the gingival margin, GR, and apical end of the stent were used as references [4].

In this split-mouth method, a simple computer-generated randomization sheet was utilized to allocate sites into the categories of test (laser application followed by bone graft [HA + β-TCP]) or control (only HA + β-TCP bone graft). The design of study, screening, recruitment, treatment, and follow-ups were in accordance with the Consolidated Standards of Reporting Trials' guidelines. All periodontal measurements were carried out by a single calibrated assessor using a University of North Carolina-15 probe.

Original bioactive glass (BG) and HA particles (SiO_2 = 43–44 wt. %, $Na_2B_4O_7.10H_2O$ = 6–7 wt. %, Na_2CO_3 = 11–12 wt. %, $CaCO_3$ = 29–30 wt. %, $(NH_4)_2HPO_4$ = 8–9 wt. %, TiO_2 = 1–2 wt. %) that were developed and used in earlier study were used in the current research [9]. HA used with TCP (RN2 Technology, Pyeongtaek, South Korea) in 60% and 40% of proportion.

Before the procedure, patients were administered Lignocaine 2% with 1:100,000 Epinephrine. The elevation of the mucoperiosteal flaps that extended from a tooth – mesial and distal – to the study tooth was performed using facial and palatal/lingual sulcular incisions. In addition, hand curettes and ultrasonic tools were used for defect debridement and root planning while osseous re-contouring was not conducted.

In the control group, osseous defects were debrided and root surface planing (without root surface conditioning) was performed. Later, a bone graft (porous HA [OssiFi, Overland Park, KS, USA]) combined with TCP and saline combination was used to fill osseous defects. To achieve maximum closure, the flaps were sutured using the interrupted stitch technique with a 3–0 black braided silk suture. Moreover, a COE-Pack was positioned as a periodontal pack, Amoxicillin 500 mg (Cipomox, Cipla Ltd, India) was given orally three times a day for 5 days, Diclofenac Sodium (Voveran. Dr Reddy's Laboratories Ltd, India) was administered three times a day for 3 days and 0.12% Chlorhexidine gluconate mouthwash was given for 2 weeks – starting on the day of surgery.

After laser sanitization, a similar surgical procedure was carried out on the test group. Prior to elevating the flaps, a diode laser (Picasso Lite Laser [AMD Lasers, inc., Dental Laser Technology, Alan Miller Company]) with a standardized wavelength of 810 nm, maximum output power of 2.5 W, and pulse duration of 20 ms was used for pocket sanitization as per the study by Gupta *et al*. The power was set at 0.8 W for a continuous wave of 20 s [4]. The laser energy was diverted away from the tooth structure by a fibre positioned on the tissue at the top of the periodontal pocket, which moved toward the bottom of the pocket. This fiber kept in contact with the soft-tissue lining of the pocket as it was moved both vertically and horizontally.

All patients' clinical and radiologic measurements, including RCAL, PD, GR, PI, and GI, were taken at baseline, after 3 months and after 6 months. Moreover, a parallel radiographic assessment was conducted using a millimeter grid. The radiographic parameter was set at 70 kVp and 8 mA with a 0.8 s exposure time for all cases. To track the hard-tissue fill, the variation in the pre- and post-operative radiographic distance between the cement enamel junction and the base of the intrabony defect was calculated. Boxes, 1 mm in height and width, were present in the grid, and to gather data, the number of boxes with hard-tissue fill was increased.

The obtained results were tabulated and statistically assessed using the IBM Statistical Package for the Social Sciences statistical software, version 23 (Chicago, IL, USA) with a Mann–Whitney *U* test. $P < 0.05$ was considered statistically significant.

Results

Table 1 indicates that the mean ± standard deviation (SD) for PI (mm) was 0.84 ± 0.16 at baseline, 0.76 ± 0.14 after 3 months and 0.60 ± 0.17 after 6 months. The mean ± SD for GI (mm) was 1.71 ± 0.60 at baseline, 1.12 ± 0.18 after 3 months and 0.69 ± 0.20 after 6 months. For the intra-group, there was a significant decrease in PI and GI between baseline and the 6 months posttreatment period.

Probing-pocket depth (PPD) decreased from baseline to the 3 and 6 months posttreatment points. In both groups, the difference was statistically significant (0.01). However, the inter-group comparison was not significant [Table 2]. The mean ± SD PPD (mm) in the control group was 6.76 ± 1.26 at baseline, 3.64 ± 0.64 after 3 months and 2.52 ± 0.42 after 6 months. In addition, the mean ± SD PPD (mm) in the test group was 6.62 ± 1.30 at baseline, 3.56 ± 0.88 after 3 months and 2.52 ± 0.38 after 6 months.

Table 3 indicates that the mean ± SD for GR in the control group was 4.42 ± 1.18 at baseline, 4.18 ± 1.24 after 3 months and 4.20 ± 1.3 6 after 6 months. The mean ± SD for GR in the test group was 4.34 ± 0.96 at baseline, 4.02 ± 1.36 after 3 months and 4.04 ± 1.28 after 6 months. The inter-group comparison was insignificant.

Table 1: Assessment of mean plaque index and gingival index

Time interval	Mean±SD	
	PI	GI
Baseline	0.84±0.16	1.71±0.60
After 3 months	0.76±0.14	1.12±0.18
After 6 months	0.60±0.17	0.69±0.20
Change of PI from baseline to after 3 months	0.08±0.02	1.59±0.32
Change of PI from baseline to after 6 months	0.24±0.01	1.02±0.40

SD: Standard deviation, PI: Plaque index, GI: Gingival index

Table 4 indicates that the mean ± SD for RCAL in the control group was 10.02 ± 1.94 at baseline, 9.51 ± 2.24 after 3 months and 8.78 ± 1.98 after 6 months. The mean ± SD for RCAL in the test group was 9.85 ± 1.58 at baseline, 7.50 ± 1.90 after 3 months and 6.64 ± 1.60after 6 months.

The intra-group comparison was significant regarding PPD and GR, whereas the inter-group comparison was not.

Discussion

Osseous defects can be intrabony, sub-bony, suprabony, or supracrestal. If a pocket's base is coronal or occlusal to the bone crest, it is referred to as "suprabony." However, if the pocket's apical end is below the bone crest, it is described as "intrabony" [11]. Intrabony defects come in two varieties: Crater and defect. When a subcrestal component affects the root surfaces of two adjacent teeth equally, it is called a "crater verity," but when it only affects the root surface of one tooth, it is known as an "intrabony defect verity" [12].

For complete healing to be achieved, periodontal pathogens need to be completely removed from intrabony pockets. SRP cannot achieve this alone [13]. Grafting materials, such as TCP and BG, can improve the healing of osseous defects and ensure regeneration. Antibiotics have a limited role, as there is a chance that they can offer resistance against bacterial development [3,4]. The current research was conducted to evaluate the healing of intrabony defects following bone graft and laser application.

We found a significant decrease in PI, GI, and pocket depth between baseline and the 6-month posttreatment period in both the groups. Similarly, Kaushick *et al*. found decrease in plaque and pocket depth after 6 month in both test and control groups (HA + β-TCP bone graft alone and in combination with PRP) and likewise Gupta *et al*. also found decrease in PI and pocket depth [3,4].

Attia *et al*. stated that low-level diode laser therapy is beneficial when managing infrabony defects [14]. For patients with aggressive periodontitis, the effectiveness of diode lasers was assessed by Kamma *et al*. and they found that, after 6 months, there was a significantly lower level of *Treponema denticola* and *Porphyromonas gingivalis*, in the scaling and root planing (SRP) and diode laser treatment laser assisted scaling treatment (LAS) group. Moreover, there was a slight increase in clinical attachment level while PD decreased in the SRP + LAS group [15]. Roncati *et al*. also found that, diode

Table 2: Assessment of mean probing pocket depth (mm)

Groups	Time interval					*P*
	Baseline	After 3 months	After 6 months	Change of PPD from baseline to after 3 months	Change of PPD from baseline to after 6 months	
Group I (bone graft)	6.76±1.26	3.64±0.64	2.52±0.42	3.12±0.32	4.24±0.74	0.01
Group II (bone graft + laser)	6.62±1.30	3.56±0.88	2.52±0.38	3.06±0.31	4.10±0.40	0.02
Difference	0.14±0.14	0.12±0.14	0.00±0.14	0.26±0.01	0.24±0.34	
P	0.81	0.82	1	0.81	0.93	

$P<0.05$. PPD: Probing pocket depth

lasers are effective at reducing PPD and increasing bone levels in patients with peri-implantitis [16]. In addition, in their evaluation of diode laser usage for pocket sanitisation prior to the implantation of bone biomaterial, Gupta *et al*. concluded that the technique did not enhance the healing of intrabony defects treated with BG [4]. Moreover, Naqvi *et al*.'s study found that BG putty is effective for intrabony defect treatment both alone and in combination with PRF [17].

HA has been the subject of most research on periodontal defects. Synthetic HA has a close (though not exact) structural and chemical resemblance to bone mineral and is biocompatible, osteoconductive and osteophilic. Through the formation of a carbonated HA surface layer, BG can form a chemical bond with living hard tissues. When BG is exposed to tissue fluid, it is covered by a silica-rich gel. Furthermore, a calcium phosphate-rich layer is created that encourages osteoblast cell absorption and concentration, which results in the formation of an extracellular matrix as well as mineralization [18].

Saima *et al*. stated that, as an aide to conventional surgery, Bioglass is efficient in infrabony defect treatment [19]. According to Kim *et al*., BG promotes and directs osteogenesis and permits quick bone formation [20]. Ong *et al*. found that BG's treated group has more PD reduction and CAL gain than the control group [21].

We found that TCP is effective in management of infrabony pocket. Similarly, Ozdemir and Okte found that, both β-TCP and PRP/β-TCP were effective in the treatment of three-walled intrabony defects [22].

Behdin *et al*. conducted a systematic review and meta-analysis. They discovered that, lasers are less effective than conventional approaches at promoting healing and regeneration [23]. In addition, Soares *et al.* discovered that, while high-level laser therapy does not appear to enhance the effect of enamel matrix derivative in the regeneration process, low-level laser therapy has a positive impact on the regeneration of periodontal tissues [24]. Bansal *et al*. stated that biphasic calcium phosphate (BCP): A mixture of HA and β-TCP, offers an additional regenerative effect in intrabony three-wall defect healing in patients with periodontitis [25]. β-TCP was reported to form bone within the periodontal osseous defects, but the new attachment was questionable. It is well known that β-TCP resorbs much faster; however, the resorbability of the material was hindered in the presence of HA. BCP ceramic with a >99% crystalline structure, was introduced as a grafting material in various types of bone defects, including periodontal and peri-implant, and is composed of 60% HA and 40% β-TCP in particulate form. Preclinical data suggest that this ratio may enable improved control of the graft material's bio-absorbable capacity [25].

Table 3: Assessment of mean gingival recession (mm)

Time interval	Group I	Group II	Difference	*P*
Baseline	4.42±1.18	4.34±0.96	0.18±0.26	0.87
After 3 months	4.18±1.24	4.02±1.36	0.26±0.38	0.74
After 6 months	4.20±1.36	4.04±1.28	0.16±0.36	0.64
Change of GR from baseline to after 3 months	0.24±0.36	0.32±0.20	0.08±0.16	0.84
Change of GR from baseline to after 6 months	0.20±0.38	1.30±0.22	0.28±0.16	0.80
P	0.01	0.02		

P<0.05. GR: Gingival recession

It has been stated that, lasers lack the capacity to sterilize a periodontal pocket, because diode laser wavelength is greatly absorbed by pigmented tissue and has high selectivity to chromophores. Lasers kill bacteria at higher dose compared to lower dose [4]. Hence in the present study we found insignificant result between test and control group similar to Gupta *et al*. study [4].

The current research found that the bone graft (HA + β-TCP combination) along with diode laser and graft combination alone are effective in infrabony defect treatment; however, the inter-group comparison was not significant. The bone graft is useful in reducing bony defects and applying lasers, helps to eliminate the microorganisms from the pockets. None of the patients reported any adverse reaction to the graft material during or after the procedure, and they all maintained good oral hygiene throughout the entire investigation.

Limitation of the study

There are many confounding factors exists, including the medications use or underlying disease. We have excluded the cases with underlying medical condition and who are under medication to avoid bias. There was the lack of comparison with other regenerative materials. Other drawback of this research was the use of a small sample size. This made it impossible to draw firm conclusions on the effects of laser pocket debridement. Further studies with larger samples are required to validate the results and evaluate the true outcomes of laser therapy on regenerated periodontal tissues.

Conclusion

The study found that both the bone graft (HA + β-TCP) and diode lasers were effective in infrabony defect treatment. However, the latter alone appears to be inferior to the one use

Table 4: Assessment of mean relative clinical attachment level (mm)

Groups	Time interval					*P*
	Baseline	After 3 months	After 6 months	Change of RCAL from baseline to after 3 months	Change of RCAL from baseline to after 6 months	
Group I (bone graft)	10.02±1.94	9.51±2.24	8.78±1.98	0.51±0.30	1.24±0.04	0.01
Group II (bone graft + laser)	9.85±1.58	7.50±1.90	6.64±1.60	2.35±0.32	3.21±0.02	0.02
Difference	0.27±0.46	0.11±0.24	0.14±0.28	0.26±0.02	0.23±0.02	
P	0.81	0.88	0.72	0.93	0.72	

P<0.05. RCAL: Relative clinical attachment level of BG. Moreover, the TCP bone graft was discovered to be beneficial in reducing bony defects, while laser application proved effective in eliminating the microorganisms from the pockets.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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