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Effect of Low Level Laser Therapy and Bioactive Glass in the Treatment of Periodontal Infrabony Defects: A Randomized Controlled Clinical Trial

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Abstract. Several guided bone regeneration techniques have been used in the past aiming to treat infrabony defects with promising outcome. Recently, low level laser therapy (LLLT) has been introduced as an adjunctive tool with better bone and soft tissue healing due to its biostimulation and biomodulation properties. The aim of the present study is to evaluate the adjunctive effect of Gallium – Aluminium – Arsenide (GaAlAs) laser in the management of periodontal infrabony defects. This was a randomised controlled, double blinded, split mouth clinical study carried out on subjects with bilateral infrabony defects. Clinical parameters of plaque index (PI), gingival index (GI), probing pocket depth (PD) and clinical attachment level (CAL) were recorded as well as infrabony defect depth using radiovisiograph at baseline, 3 months and 6 months intervals. The test group was treated with bioactive glass and GaAlAs laser on the 1st, 3rd, 5th and 7th day following periodontal open flap surgery and the control group received bioactive glass only. All data were collected and analyzed using Wilcoxon signed rank test and paired t-test. A total of 15 subjects were enrolled in this study. There was a significant reduction in the PD (p=0.05), CAL (p=0.01) and in defect depth observed at 6 months interval in the test group compared to control group. Based on the current data, the application of LLLT as an adjunctive tool with bioactive glass may have a superior outcome in treating infrabony defects compared to bioactive glass alone.

Keywords: soft laser, infrabony defects, perioodontitis.

1. Introduction

Periodontal regeneration has been introduced as a concept to reconstitute the lost periodontium evidenced histologically in the form of new cementum, periodontal ligament, and alveolar bone [1]. In the past several decades, different grafting techniques and materials have been implemented in the periodontal practice including autogenous grafts, allogeneic grafts and bone substitutes [2]. Out of all, bioactive glass is a biocompatible graft material which has been used regularly in the dental practice for socket preservation, alveolar ridge grafting and management of periodontal infrabony defects [3]. It is an inorganic, synthetic composites which could serve as a bone substitute providing three dimensional porous material for osteoinduction and osteoconduction used as a lower cost option with outcomes comparable to other graft materials

[3]. Following defect grafting, histological studies have demonstrated formation of new bone and connective tissue at 6 months [4].

In order to improve treatment outcomes, dental lasers have been introduced in the field of dentistry as an adjunctive supporting tool with several applications [5-8]. Compared to other dental lasers, low level laser therapy (LLLT) generates a single wavelength light with biomodulatory and biostimulatory effects on oral tissues [8]. As a result, LLLT is likely to recruit and activate osteoblasts, osteosynthesis, with a decrease in osteoclastic activity and anti-inflammatory action to enhance periodontal tissue healing [9]. However, the exact role of LLLT in periodontal treatment is not fully understood and has to be further investigated.

Hence, several small studies hypothesized that the combination of bioactive glass grafting material with the anti-microbial effect of LLLT may provide a promising treatment option for periodontal defects [10, 11]. Therefore, this study aimed at assessing the adjunctive effect of LLLT on bone regeneration for the treatment of periodontal infrabony defects combined with bioactive glass. The outcome of this study will help to better understand the exact indication of LLLT and its supportive role.

2. Materials and Method

This study was a randomized controlled, parallel, double-blinded split-mouth investigation conducted at the Department of Periodontics, M.A. Rangoonwala Dental College and Research Centre, Pune, India. The study received approval from the institutional ethical committee (HREC number 4617/2012CTRI/2015/03/005636 - Clinical Trials Registry- India - www.ctri.nic.in). Inclusion criteria encompassed adult patients aged 18-60 diagnosed with periodontitis according to the 2017 periodontal classification, bilateral periodontal infrabony defects in either the maxilla or mandible, periodontal pockets with depth ≥5mm post phase 1 therapy, radiographic evidence of vertical bone loss (at least 3 mm from the alveolar crest to the base of the defect), and 2- or 3-wall defects amenable for regenerative procedures [12, 13]. In addition, only non-mobile or teeth with grade 1 mobility were included in the study. Exclusion criteria included systemic diseases, smoking or any form of smokeless tobacco use, pregnancy, lactation, non-compliance, and long-term use of antibiotics, corticosteroids, or current radiotherapy. The primary outcome assessed was the reduction in periodontal defect depth and gain in clinical attachment level (CAL); secondary outcomes included improvement in plaque index (PI), gingival index (GI), and probing depth (PD).

Before initiation, a study power and sample size analysis were conducted, determining that 10 sites per group were required per calculation to achieve 90% power. In addition, all study co-investigator were calibrated for data collection. Informed consent was obtained from all subjects at enrolment. Selected sites were randomly assigned to receive either bioactive glass with low-level laser therapy (LLLT) (test group) or bioactive glass alone (control group) using a flip of a coin. All subjects underwent Phase 1 periodontal therapy, including deep scaling, root planning, and oral hygiene instructions. Four weeks later, subjects were recalled for periodontal re-evaluation. A reference acrylic stent was fabricated to standardize the direction of the periodontal probe during examination, and radiographs were taken using a paralleling cone technique.

All measurements were recorded by calibrated examiners. Clinical parameters (PI, GI, PD, and CAL) were assessed at baseline, 3 and 6 months using an acrylic stent for accuracy. In addition, radiovisiography (RVG 5000, Eastman Kodak, Rochestor, NY) using an intra-oral film with millimetre grid (1 mm box hight and width) were used for measuring infrabony defects and bone fill. Defect depth (DD) measurement included the vertical distance from the cemento-enamel junction (CEJ) to the deepest point of the defect and horizontal distance from

CEJ to the base of the defect (BD). Specific radiographic measurements were collected at baseline, 3 months, and 6 months.

All surgical procedures were performed by a single certified periodontist (PAD). The surgical area was anesthetized using 2% lidocaine with 1:200,000 adrenaline. Crevicular incision was performed, and a full-thickness mucoperiosteal flap was elevated via blunt dissection using a periosteal elevator (Fig. 1 & 2). Following mechanical debridement, periodontal defects were filled with bioactive glass (Perioglass, Novabone products LLC, USA), and flaps were approximated with vicryl 5-0 interrupted sutures. For the test group, a GaAlAs laser (DR. Laser 200, 10DL001, KONDI Electrical Deposit Corporation, Hungary) with a wavelength in the visible red spectrum (660 nm) and average output power of 25mW was applied for 3 minutes in a sweeping motion at continuous mode [10]. The laser treatment was applied postoperatively on the day of surgery (Day 0) and on Days 3, 5, and 7. For the control group, a similar application was delivered with an inactive laser device. At the time of laser application, both the patient and investigator were blinded. Postoperative instructions included a prescription for diclofenac sodium (50 mg) and paracetamol (325 mg) to be taken three times a day for 3 days. Additionally, amoxicillin 500 mg taken three times for 5 days and 0.2% chlorhexidine mouth rinse were prescribed to be used twice daily for 2 weeks. Patients were recalled at 1 week and 3 months for periodontal evaluation and oral hygiene reinforcement.

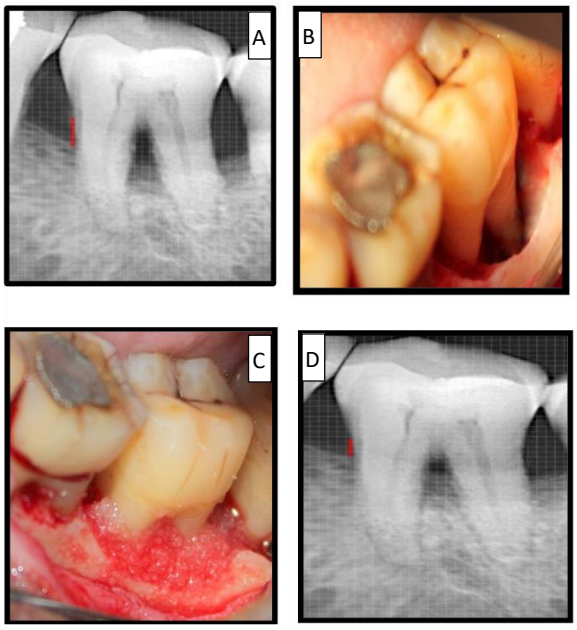

Fig. 1. Mandibular left 2nd molar in the control group showing A) preoperative radiograph with horizontal bone defect and furcation involvement at baseline (red line indicate the vertical distance from the crestal bone level to cemento-enamel junction); B) clinical image demonstrating infrabony defect in a circumferential pattern following mechanical debridement; C) defect site filled with bioactive glass; D) defect fill assessed radiographically at 3 months interval using a radiographic grid.

All collected data were analyzed using the Statistical Package for Social Sciences (SPSS version 11.5) for MS Windows version 11. The normality assumptions of the data were tested using the Shapiro-Wilk W test. Intragroup comparisons from baseline to 3 and 6 months were analyzed using Wilcoxon's signed rank test, while paired t-tests were performed for intergroup comparison.

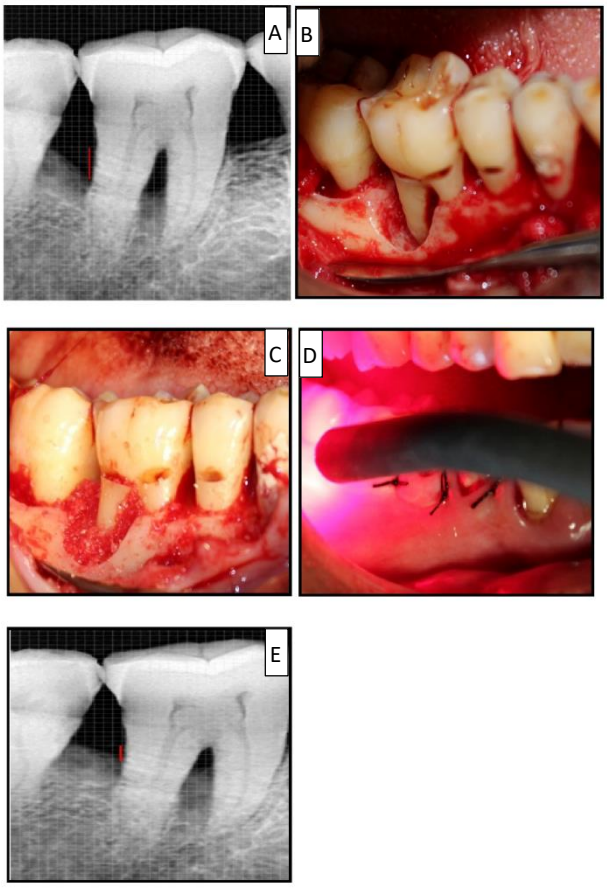

Fig. 2. Mandibular right 1st molar in the test group treated with bioactive glass and LLLT A) preoperative radiograph demonstrating horizontal bone loss with infrabony defect and furcation involvement at baseline (red line indicate the vertical distance from the crestal bone level to cemento-enamel junction); B) clinical image showing infrabony defect following mechanical debridement; C) infrabony defect filled with bioactive glass; D) surgical site sutured and followed by laser application; E) postoperative radiograph showing infrabony defect fill at 3 months interval assessed by a radiographic grid.

3. Results

A total of 15 subjects with 30 sites were enrolled in the study. Out of all, 8 sites were adjacent to maxillary and mandibular single rooted teeth, and the remaining 22 sites were adjacent to maxillary and mandibular multi-rooted teeth. The mean PI in the test site at baseline was 0.63 ± 0.30, at 3 months was 0.70 ± 0.26 and at 6 months was 0.72 ± 0.25 whereas in control sites at baseline was 0.63 ± 0.30, at 3 months was 0.76 ± 0.27 and at 6 months interval was 0.77 ± 0.27 (Table 1). There was an increase in mean PI for both test and control sites from baseline to 6 months ($p>0.01$). In addition, no statistical difference was detected between test and control sites with inter-site comparison at baseline, 3 months and 6 months interval. The mean GI of the test sites at baseline was 0.75 ± 0.23 mm, at 3 months was 0.59 ± 0.16 mm and at 6 months was 0.56 ± 0.15 mm; whereas in the control sites the mean GI at baseline was 0.63 ± 0.28 mm, at 3 months was 0.98 ± 0.47 mm and at 6 months was 0.99 ± 0.46 mm. There was an increase in the GI at 6 months compared to baseline in the control sites. Yet, the test sites showed statistically significant decrease of mean GI from baseline to 3 months ($p=0.044$) and 6 months ($p=0.041$). In addition, the percentage change of GI at 6 months interval was 57.1% in the control sites and 25.4% in the test sites. No statistical difference was noted in the inter-site comparison at 3 and 6 months interval between the sites.

Mean PD in the test site at baseline was 8.0 ± 0.82 mm, at 3 months it was 3.42 ± 0.33 mm and at 6 months it was 3.25 ± 0.54 mm (Table 2). In the control site, the mean PD at baseline was 8.80 ± 0.82 mm, at 3 months was 4.90 ± 0.66 mm and at 6 months interval was

4.10 ± 0.66 mm. There was a statistically significant decrease in PD for both control and test sites from baseline to 6 months (p=001). Inter-site comparison showed a statistical significant decrease in PD in test site compared to the control site at 3 months (p=0.001) and 6 months intervals (p=0.005). The mean CAL in the test site at baseline was 8.35 ± 0.74 mm, 4.04 ± 0.62 mm at 3 months and 3.97 ± 0.53 mm at 6 months. In the control site, the CAL at baseline was 8.15 ± 1.06 mm, 5.10 ± 0.94 mm at 3 months and 4.30 ± 0.54 mm at 6 months intervals. There was a statistically significant gain in both groups from baseline to 3 months (p=0.001) and baseline to 6 months (p=0.001). The comparison between the test and control site showed statistically significant gain in CAL in the test site compared to control site at 3 months (p=0.001) and 6 months interval (p=0.001).

Table 1. Plaque and gingival indices for test and control sites at baseline, 3 and 6 months.

Plaque Index (PI)	**Test Site**	**Control Site**	**P-value**
Baseline	0.63 ± 0.30	0.63 ± 0.30	0.999 (NS)
3-Month Post-treatment	0.70 ± 0.26	0.76 ± 0.27	0.554 (NS)
6-Month Post-treatment	0.72 ± 0.25	0.77 ± 0.27	0.688 (NS)
Intra-Group Comparisons (P-values)			
Pre-treatment v 3 Month	0.353 (NS)	0.294 (NS)	
Pre-treatment v 6 Month	0.402 (NS)	0.256 (NS)	
3 Month v 6 Month	0.843 (NS)	0.889 (NS)	
Gingival Index (GI)	**Test Site**	**Control Site**	**P-value**
Baseline	0.75 ± 0.23	0.63 ± 0.28	0.298 (NS)
3-Month Post-treatment	0.59 ± 0.16	0.98 ± 0.47	0.063 (NS)
6-Month Post-treatment	0.56 ± 0.15	0.99 ± 0.46	0.060 (NS)
Intra-Group Comparisons (P-values)			
Pre-treatment v 3 Month	0.044 (S)	0.068 (NS)	
Pre-treatment v 6 Month	0.041 (S)	0.143 (NS)	
3 Month v 6 Month	0.890 (NS)	0.946 (NS)	

*S=significant; NS=non-significant.

Table 2. Periodontal probing depths and clinical attachment levels for test and control sites at baseline, 3 and 6 months.

Probing Pocket Depth (PD)	**Test Site**	**Control Site**	**P-value**
Baseline	8.00 ± 0.82	8.80 ± 0.82	0.592 (NS)
3-Month Post-treatment	3.42 ± 0.33	4.90 ± 0.66	0.001 (S)
6-Month Post-treatment	3.25 ± 0.54	4.10 ± 0.66	0.005 (S)
Intra-Group Comparisons (P-values)			
Pre-treatment v 3 Month	0.001 (S)	0.001 (S)	
Pre-treatment v 6 Month	0.001 (S)	0.001 (S)	
3 Month v 6 Month	0.284 (NS)	0.011 (S)	
Relative Attachment Level (CAL)	**Test Site**	**Control Site**	**P-value**
Baseline	8.35 ± 0.74	8.15 ± 1.06	0.631 (NS)
3-Month Post-treatment	4.04 ± 0.62	5.10 ± 0.94	0.001 (S)
6-Month Post-treatment	3.97 ± 0.53	4.30 ± 0.54	0.001 (S)
Intra-Group Comparisons (P-values)			
Pre-treatment v 3 Month	0.001 (S)	0.001 (S)	
Pre-treatment v 6 Month	0.001 (S)	0.001 (S)	
3 Month v 6 Month	0.460 (NS)	0.011 (S)	
Defect Depth (DD)	**Test Site**	**Control Site**	**P-value**
Baseline	6.90 ± 0.46	6.77 ± 0.75	0.646 (NS)
3-Month Post-treatment	1.50 ± 0.67	3.21 ± 0.86	0.001 (S)
6-Month Post-treatment	1.30 ± 0.59	3.00 ± 0.82	0.001 (S)
Intra-Group Comparisons (P-values)			
Pre-treatment v 3 Month	0.001 (S)	0.001 (S)	
Pre-treatment v 6Month	0.001 (S)	0.001 (S)	
3 Month v 6 Month	0.037 (S)	0.075 (NS)	

*S=significant; NS=non-significant

In terms of mean DD in the test sites, it was 6.90 ± 0.46 mm at baseline, 1.50 ± 0.67 mm at 3 months and 1.30 ± 0.59 mm at 6 months intervals. The mean BF at 3 months was 5.40 mm

and 5.60 mm at 6 months. In the control sites, the mean DD at baseline was 6.77 ± 0.75 mm, 3.21 ± 0.86 mm at 3 months and 3.00 ± 0.82 mm at 6 months intervals. The mean BF at 3 months was 3.56 mm and 3.77 mm at 6 months intervals. A significant reduction in the DD was observed in both groups from baseline to 6 months (p=0.001). With inter-site comparison, the test sites showed significant reduction in DD and significant increase in the BF from baseline to 3 months (p=0.001) and 6 months (p=0.001) when compared to control sites.

4. Discussion

Periodontal disease is a prevalent condition known to have adverse effects on both teeth and the surrounding tissues [14]. Various treatment options are available, all aimed at achieving pocket reduction or elimination, as well as restoring lost periodontal tissues through the formation of new attachments and periodontal regeneration [15]. Consequently, numerous regenerative modalities have been suggested, encompassing soft and hard tissue grafting, coupled with adjunctive tools such as growth factors, antimicrobial agents, and laser therapy [16, 17]. Therefore, the objective of this study was to assess the impact of Low-Level Laser Therapy (LLLT) on the regeneration of periodontal defects in conjunction with the bioactive glass grafting procedure.

Various types of Low-Level Laser Therapy (LLLT) are available in the market, including Helium-Neon (He-Ne) and Ga-Al-As. In this study, we utilized a Ga-Al-As laser operating at a wavelength of 660 nm, in combination with bioactive glass, as an optimal approach due to its osteoconductive and osteostimulative properties [3, 10]. The chosen pore size of the bioactive glass facilitated optimal vascularization and provided an additive hemostatic effect [10]. No significant difference in Plaque Index (PI) was observed between the two groups at baseline, 3 months, and 6 months, likely attributable to the participants' effective maintenance of oral hygiene. However, an increase in PI scores from baseline to 3 months was noted for both groups (p=0.554), possibly due to challenges in maintaining proper oral hygiene post-surgery.

The Gingival Index (GI) in the test group exhibited improvement compared to the control site post-treatment (p=0.060). Furthermore, a significant difference in GI was observed in the test group at the 3 and 6-month time points compared to baseline. This improvement may be attributed to the adjunctive effect of LLLT, known to stimulate wound healing by enhancing the motility of human epidermal keratinocytes in vitro [18]. A study by Qadri et al., involving a split-mouth, double-blinded controlled clinical trial, demonstrated the application of LLLT in treating inflamed gingival tissues in patients with moderate periodontitis, resulting in reduced Probing Depth (PD), PI, and GI with decreased metalloproteinase-8 at 6 weeks [8]. In our study, a statistically significant difference was noted between the test and control groups in terms of PD, Clinical Attachment Level (CAL), and radiographic reduction in Defect Depth (DD). Additionally, no significant difference was observed between 3 and 6 months in the control sites compared to the test site, suggesting the regenerative and continuous benefits of adjunctive laser therapy over time for both hard and soft tissues.

Kreisler et al. conducted an in vitro study irradiating human periodontal ligament fibroblasts (PDLFs) with a diode laser, resulting in considerably higher proliferative activity of PDLFs compared to the control group. This increased proliferative activity could contribute to the formation of new connective tissue attachment and reduction in probing depths [19]. At the end of the study, there was a considerably higher proliferative activity of PDLFs compared to control which could aid in formation of new connective tissue attachment and reducing probing depths. Behdin et al. and Merli et al. reported the efficacy of LLLT irradiation at 0, 3, 5 and 7 day intervals on bone regeneration in mid-palatal suture during expansion in rats and on the progress of bone regeneration respectively [20, 21].

The proposed mechanism of periodontal regeneration with laser application focuses on increase in collagen and DNA synthesis, faster removal of necrotic tissues and increase in osteoblast function [22]. Other advantages included neo-vascularisation, earlier differentiation of mesenchymal cells and increase of pre-osteogenic cells [22, 23]. AboElsaad et al evaluated the effect of 830 mm GaAlAs laser along with bioactive bone graft material for bone regeneration histologically and clinically in bilateral periodontal infrabony defects in 20 patients [10]. The study reported a cumulative effect of GaAlAs laser on the synthesis of bone matrix due to increased vascularization and early onset of inflammatory healing and biomodulation of non-differentiated mesenchymal cells forming osteoblasts and osteocytes; thus increased bone fill. This particular study had similar study design to the current study, and reported a positive effect of LLLT in periodontal wound healing.

The outcome of this study shed the light on the possible role of adjunctive LLLT in management of periodontal defects. In addition, it may justify the application of LLLT in management of other periodontal procedure which may include soft tissue grafting and implant therapy. The current study has several limitations. Firstly, the small number of enrolled subjects/sites may limit the comprehensive confirmation of the study outcomes. Secondly, the assessment of treatment outcomes for infrabony defects was conducted solely through clinical and radiographic methods. While histological studies are considered the gold standard for evaluating periodontal regeneration, radiographic documentation is regarded as a valid, non-invasive, and painless alternative tool for direct bone measurement, as utilized in this study [19]. Recognizing 6 months as the minimum duration required for radiographically evident bone changes, Radiovisiography (RVG) was employed to measure defect depths at baseline, 3 months, and 6 months intervals [10, 19]. Thirdly, bioactive glass served as the exclusive graft material in this study. Future investigations incorporating other allo- and xeno-graft materials are necessary for outcome comparisons.

5. Conclusion

According to the existing data, the application of bioactive glass with adjunctive LLLT for managing periodontal defects may lead to a gain in CAL and a radiographic reduction in DD. However, additional studies with larger sample sizes are necessary to validate the current findings.

Disclosure Statement

No financial support was obtained for the research and there was no conflict of interest related to the study. The study follows the CONSORT guidelines for randomized clinical trials.

Authors' Contribution

Danish P: Study design, participants recruitment, conduction of the study

Othman B: Study design, data gathering and analysis

Altassan M: Study design, data gathering and analysis, writing the manuscript

Alghaleb T: Study design, data gathering and analysis

Niazi A: Study design, data gathering and analysis, writing the manuscript

Dakhil S: Study design, data gathering and analysis

Aboalela A: Study design, writing the manuscript

Alharbi M: Study design, data gathering and analysis

Mawardi H: Study design, data gathering and analysis, writing the manuscript

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تأثير العلاج بالليزر منخفض المستوى والزجاج النشط بيولوجيًا في علاج عيوب الطبقة تحت العظمية للثة: تجربة سريرية عشوائية محكومة

دانيش باثان[١]، وشريا توراخيا[٢]، وبدر عثمان[٣]، وموسى الطاسان[٤]، وثامر الغالب الشريف[٥]، وأدهم نيازي[٥]، وسراج دخيل[٦]، وعلي أبو العلا[٧]، ومحمد الحربي[٦]، وهاني ماوردي[٨]

[١] قسم أمراض اللثة، كلية طب الأسنان ومركز الأبحاث إم. إيه. رانجونوالا، بوني، الهند؛ شريا بي دوشي، بكالوريوس جراحة الأسنان، ماجستير جراحة الأسنان، و[٢] أخصائية أمراض اللثة، عيادة خاصة، مومباي، ماهاراشترا، الهند، و[٣] قسم أمراض اللثة، جامعة الملك عبد العزيز، كلية طب الأسنان، جدة، المملكة العربية السعودية، و[٤] قسم طب الأسنان التعويضي، جامعة الملك عبد العزيز، كلية طب الأسنان، جدة، المملكة العربية السعودية، و[٥] قسم طب الأسنان التعويضي، كلية البترجي لطب الأسنان، جدة، المملكة العربية السعودية، و[٦] قسم علاج لب الأسنان، جامعة الملك عبد العزيز، كلية طب الأسنان، جدة، المملكة العربية السعودية، و[٧] قسم جراحة الوجه والفكين وعلوم التشخيص، كلية طب الأسنان، جامعة الملك سعود بن عبد العزيز للعلوم الصحية (KSAU-HS)، الرياض، المملكة العربية السعودية؛ و[٨] مركز الملك عبد الله الدولي للأبحاث الطبية، الرياض، المملكة العربية السعودية؛ خدمات طب الأسنان، وزارة الحرس الوطني – الشؤون الصحية، الرياض، المملكة العربية السعودية، وقسم علوم الفم والتشخيص، جامعة الملك عبد العزيز، كلية طب الأسنان، جدة،، المملكة العربية السعودية

المستخلص. تم استخدام العديد من تقنيات بناء العظام الموجه في الماضي بهدف علاج الجيوب العظمية حول الاسنان بنتائج واعدة. مؤخرًا، تم إدخال العلاج بالليزر منخفض الشدة (LLLT) كأداة مساعدة لتحسين شفاء العظام والأنسجة اللثوية بفضل خصائصه في التحفيز البيولوجي والتعديل الحيوي. يهدف البحث الحالي إلى تقييم التأثير المساعد لليزر جاليوم–ألومنيوم–أرسينيد (GaAlAs) في علاج الجيوب العظمية حول الاسنان والمرتبطة بأمراض اللثة. تم إجراء هذه الدراسة السريرية بشكل عشوائي مزدوج التعمية باستخدام تصميم الفم المقسّم على مرضى يعانون من جيوب عظمية ثنائية حول الاسنان. تم تسجيل المعايير السريرية بما في ذلك مؤشر اللويحة السنية (PI)، مؤشر اللثة (GI)، عمق جيب اللثوي (PD)، ومستوى الالتصاق اللثوي (CAL)، بالإضافة إلى قياس عمق الجيب العظمي باستخدام الأشعة الرقمية (radiovisiograph) قب بداية الدراسة، وبعد ٣ أشهر، و٦ أشهر. تم علاج المجموعة الاختبارية باستخدام الزجاج الحيوي مع ليزر GaAlAs في اليوم الأول، الثالث، الخامس، والسابع بعد إجراء جراحة رفع اللثة المفتوحة، بينما تلقت المجموعة الضابطة الزجاج الحيوي فقط. تم جمع وتحليل البيانات باستخدام اختبار الرتب الموقعة لولكوكسون (Wilcoxon signed rank test) واختبار t المزدوج (paired t-test). شارك في الدراسة ١٥ مريضًا. أظهرت النتائج انخفاضًا ملحوظًا في عمق الجيب (p=0.05)، ومستوى الالتصاق اللثوي (p=0.01)، وعمق الجيب العظمي بعد ٦ أشهر في المجموعة الاختبارية مقارنة بالمجموعة الضابطة. استنادًا إلى البيانات الحالية، قد يكون لاستخدام الليزر منخفض الشدة (LLLT) كأداة مساعدة مع الزجاج الحيوي تأثير متفوق في علاج الجيوب العظمية حول الاسنان مقارنة باستخدام الزجاج الحيوي وحده.

الكلمات المفتاحية: الليزر الناعم، عيوب ما تحت العظم، التهاب دواعم الأسنان.