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CASE REPORT

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Applications of diode laser in periodontal therapy – clinical guidelines and tips

Aplicações do laser de diodo na terapia periodontal – Orientações e dicas clínicas

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ABSTRACT

The diode lasers have become popular clinical tools because of their compact size, affordability, ease of use and versatility. The aim of this paper is to put forth the various applications of a diode laser in day to day practice and highlight the technical aspects of diode laser use for the same. This case series reports management of six different clinical situations with diode laser namely – ankyloglossia, periodontal pocket, unequal gingival zeniths, mucocele, dentinal hypersensitivity and hyper-pigmented gingiva. The patients were treated with 940 nm diode laser with power settings from 0.5 W to 2 W depending on the case. The post-operative healing was uneventful in most cases and favourable outcomes were observed. The diode laser offered surgical advantages like – dry field, disinfection of surgical site and suture-less surgery. In addition, the authors observed better patient satisfaction owing to minimal post-operative pain or swelling and immediate relief in case of dentinal hypersensitivity. This paper presents both surgical and non-surgical applications of diode laser along with the technical aspects. Even though the available literature does not lend substantial evidence for direct comparison of diode laser with conventional techniques, it is safe to conclude that diode laser is an efficient tool for routine use in dentistry.

KEYWORDS

Laser therapy; Gingivectomy; Ankyloglossia; Periodontal pocket; Dentin sensitivity; Esthetics dental.

RESUMO

Os lasers de diodo tornaram-se ferramentas clínicas populares devido ao seu tamanho compacto, acessibilidade, facilidade de uso e versatilidade. O objetivo deste artigo é apresentar as diversas aplicações de um laser de diodo na prática diária e destacar os aspectos técnicos do uso do laser de diodo para o mesmo. Esta série de casos relata o manejo de seis diferentes situações clínicas com laser de diodo: anquiloglossia, bolsa periodontal, zênites gengivais desiguais, mucocele, hipersensibilidade dentinária e gengiva hiperpigmentada. Os pacientes foram tratados com laser de diodo de 940 nm com potência de 0,5 W a 2 W dependendo do caso. A cicatrização pós-operatória transcorreu sem intercorrências na maioria dos casos e foram observados resultados favoráveis. O laser de diodo ofereceu vantagens cirúrgicas como – campo seco, desinfecção do sítio cirúrgico e cirurgia sem sutura. Além disso, os autores observaram melhor satisfação do paciente devido à mínima dor ou edema pós-operatório e alívio imediato em caso de hipersensibilidade dentinária. Este artigo apresenta as aplicações cirúrgicas e não cirúrgicas do laser de diodo juntamente com os aspectos técnicos. Embora a literatura disponível não forneça evidências substanciais para comparação direta do laser de diodo com as técnicas convencionais, é seguro concluir que o laser de diodo é uma ferramenta eficiente para uso rotineiro em odontologia.

PALAVRAS-CHAVE

Terapia a laser; Gengivectomia; Anquiloglossia; Bolsa periodontal; Sensibilidade da dentina; Estética dentária.

INTRODUCTION

The term 'LASER' is an acronym for 'light amplification by stimulated emission of radiation'. In simple words, laser light is a stream of man-made single wavelength photons. Lasers concentrate light energy and exert a strong effect at the targeted tissue. The introduction of Nd:YAG laser in 1990, in the United States, marked the beginning of laser dentistry. As of today the most commonly used lasers in dentistry are the CO2, diode, Nd:YAG and Er:YAG.

The diode laser is a solid-state semiconductor laser which uses a combination of Gallium (Ga), Arsenide (Ar), and other elements such as Aluminum (Al) and Indium (In). The wavelength of a diode laser ranges between 800– 980 nm. The diode laser is poorly absorbed in water, but highly absorbed in tissue pigments such as haemoglobin and melanin [1]. The depth of penetration of a diode laser is around 4-6mm [2]. These properties of the diode laser facilitate its use in soft –tissue surgery, pocket therapy, photodynamic therapy, endodontic disinfection, bio-stimulation, tooth whitening and pain therapy [3].

The aim of this paper is to put forth guidelines for various photothermal and photobiomodulation applications diode laser in periodontal therapy through a presentation of various cases and highlight the technical aspects of diode laser use for the same.

CLINICAL TECHNIQUE AND CASE DESCRIPTION

All procedures were performed on systemically healthy patients with prior informed consent. The diode laser (Ezlase, Biolase, USA, 940 nm) was used at high power (> 0.5 W) for its photothermal effect for frenectomy, excision, gingivectomy and pocket therapy whereas it was used at low power (< 0.5 W) for the management of dentinal hypersensitivity.

Case 1 (Ankylossia)

The first patient was a 23 year old male patient reported to the dental hospital with restricted tongue movement and difficulties in speech since childhood. The patient had a very short lingual frenum which restricted protrusive, lateral and upward movement of the tongue (Figure 1). The lingual frenum was evaluated by the treating periodontist and the examination confirmed the diagnosis of ankyloglossia. The free-tongue length was evaluated and tongue tie was classified as per Kotlow's classification into Class II (Moderate) [4]. Local infiltration was administered on either side of the frenum using lignocaine (**Lignox 2% A,** containing 2% lignocaine hydrochloride and 1:80000 adrenaline). The frenectomy was performed with diode laser (Ezlase, Biolase, USA, 940 nm) connected to a 400 μm tip. The laser was set at 2 W power and pulsed mode. The tongue was retracted using a plastic tweezer and the initiated laser tip was activated and operated in contact mode (Figure 2). Intermittent light brush stroke movements of the tip were used to cut the frenum from the apex to the base. Tongue movements were performed post-operatively to ensure separation of all the fibres. Patient was prescribed analgesics (Diclomol, Diclofenac Sodium 50 mg and Paracetemol 325 mg combination, twice daily for 3 days) and topical anaesthetic gel (Mucopain gel, Benzocaine 20% w/w, three times a day half an hour before meals). The patient was advised

Figure 1 - Pre-operative view depicting restricted tongue movement.

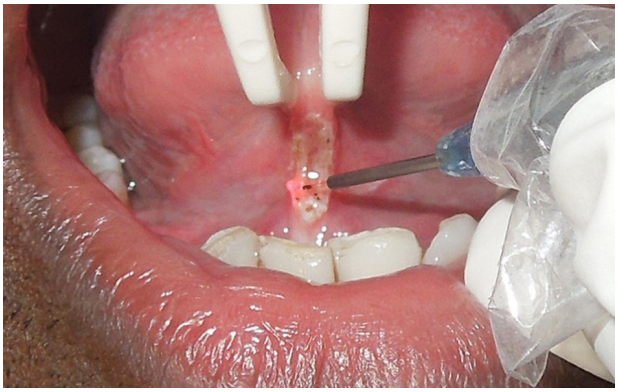

Figure 2 - Intraoperative view of laser frenectomy.

10 repetitions of the following tongue exercises post – operatively, thrice daily for 4 weeks [5,6]:

- Patient was advised to move the tongue forward and touch the nose followed by downward movement towards the chin, followed by side to side movement;
- Patient was advised to perform circular movements of the tongue in clockwise and anti-clockwise direction;
- Patient was advised to protrude the tongue as forward as possible;
- Patient was advised to position the tongue at the anterior, middle and posterior regions of hard palate and open and close the mouth;
- Lift the tip of the tongue just behind the incisive papilla;
- Patient was advised to place the back of the tongue against the palate and suck air to create a vacuum followed by slow opening of the mouth to stretch lingual frenum.

The patient was advised a soft and cold diet for 1 week. To facilitate in plaque control, the patient was also prescribed 0.2% Chlorhexidine gluconate mouthwash (Hexidine Mouthwash). The patient was instructed to rinse with 10 ml of undiluted mouthwash for 30 seconds, twice daily for one week. At one week follow-up, the frenectomy site exhibited uneventful healing in progress. However the patient described minor discomfort during tongue exercises which was relieved with topical anaesthetic gel. At 4 weeks, the patient was completely symptom free and complete wound healing was observed along with significant improvement in tongue movements (Figure 3).

Case 2 (Crown lengthening)

The second patient was a 21 year old female, who was referred to the clinic for aesthetic gingival correction post orthodontic therapy. The examination revealed mismatched zeniths with 11, 21 and a short clinical crown with 13 (Figure 4). The patient had a high smile line necessitating gingival correction for optimal esthetics. Local infiltration anaesthesia with lignocaine (**Lignox 2% A,** containing 2% lignocaine hydrochloride and 1:80000 adrenaline) was administered and trans-gingival probing was done to determine biologic width. The dimensions permitted excision of only soft tissue to allow a biologic width of 3mm post-op. Bleeding points were marked with a periodontal probe on the gingiva of 11 and 13 at the desired levels. A 400 μm tip was connected to the diode laser (Ezlase, Biolase, USA, 940 nm) and initiated. The power settings of the laser were adjusted to 1.5 W and it was operated in pulse mode. The activated laser tip was used with light brush-like strokes and the excess tissue was cut along the bleeding points (Figure 5). Topical gel containing 2% lignocaine, 1% Chlorhexidine and 1% metronidazole was

Figure 3 - Post-operative view depicting improvement in tongue movement.

Figure 4 - Pre-operative view depicting gingival asymmetry.

Figure 5 - Intraoperative view of laser gingivectomy.

prescribed post-operatively, twice daily for 3 days (Rexidin M Forte Gel). The patient was advised to use extra soft tooth – brush for plaque control and avoid hot and spicy food for 1 week. The post-operative period was uneventful, the patient did not experience any pain or discomfort post-operatively and complete healing was observed at 1 week post-operatively (Figure 6).

Case 3 (Mucocele excision)

The third case was a 35 year old male, who reported to the clinic with a chief complaint of swelling on the lower lip since 15 days. The patient revealed that the swelling had developed after an accidental lip bite. On examination a soft, dome shaped swelling with a bluish surface measuring 5mm in diameter on the lower lip suggestive of a Mucocoele (Figure 7). Local infiltration with lignocaine (**Lignox 2% A,** containing 2% lignocaine hydrochloride and 1:80000 adrenaline) was given around the lesion. The lower lip was stretched to place the tissue under tension. The excision was performed with diode laser (Ezlase, Biolase, USA, 940 nm) using a 400μ tip adjusted to a power setting of 1.5W and pulse mode. The initiated laser tip was activated and directed along the margins of the mucocele to facilitate excision of the entire pathology. In order to prevent collateral thermal damage the laser beam was directed towards the discard tissue [7]. Patient was prescribed analgesic (Diclomol, Diclofenac Sodium 50 mg and Paracetemol 325 mg combination, twice daily for 3 days) and topical anaesthetic gel (Mucopain gel, Benzocaine 20% w/w, three times a day half an hour before meals) post-operatively. The patient was advised to avoid manipulation of the lower lip, avoid consumption of hot and spicy foods for 1 week and continue with routine oral hygiene practices. In contrast to the reports of faster healing, the healing was delayed in this case and the patient experienced pain for 1 entire week and discomfort for 2 weeks post-operatively. The patient reported the need to use analgesics for 1 week and topical anaesthetic gel for 2 weeks after the excision. Complete healing was seen only at 3 weeks (Figure 8). The patient was followed for a period of 3 months and remained lesion free during the period of follow – up.

Case 4 (Depigmentation)

The fourth case was a 19 years old female, who reported with the complaint of dark gums and wanted treatment for the same. On examination uniformly pigmented attached gingiva and slight discrepancy in the gingival contour was noted (Figure 9). The procedure was performed under local infiltration with lignocaine (**Lignox 2% A,** containing 2% lignocaine hydrochloride and 1:80000 adrenaline). De-pigmentation was done using diode laser (Ezlase, Biolase, USA, 940 nm). The attached gingiva was de-epithelialized using a 400 μm tip at 1.5 W power setting and pulse mode for de-pigmentation. A systemic analgesic (Combiflam, Brufen 400 mg and Paracetemol

Figure 6 - Post-operative view depicting gingival symmetry.

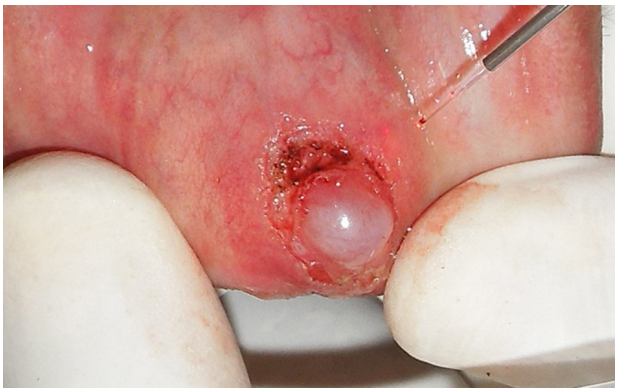

Figure 7 - Intraoperative view depicting laser excision of mucocele.

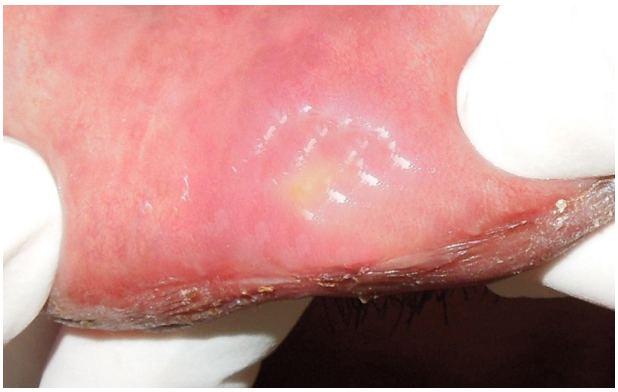

Figure 8 - Post-operative view.

325 mg combination) was prescribed for 2 days, thrice daily post-operatively. The patient was instructed to avoid brushing in the area of surgery for 3 days and to facilitate with plaque control mouth rinsing with 10 ml, 0.2% chlorhexidine (Hexidine Mouthwash) was advised twice daily for 7 days. Additionally, the patient was instructed to avoid consumption of hot and spicy foods for 1 week. The patient was informed to resume gentle brushing from the 4th day post-operatively using an ultra-soft tooth brush. Complete healing was seen on the 14 day recall visit and the patient did not report any pain or discomfort during the post-operative period (Figure 10).

Case 5 (Pocket therapy)

The fifth case was that of a 30 year old male patient, who reported to the clinic with a chief complaint of bleeding gums from the upper front tooth. The patient also gave history of trauma and root canal treatment with the same tooth 2 years back. The clinical examination revealed presence of 5mm and 7 mm pocket on the facial and mesial aspects of 11 respectively (Figure 11). Additionally, recession measuring upto 3 mm was present on the facial and mesial aspect of 11. In order to prevent further recession in the aesthetic zone it was decided to treat the pocket non – surgically using diode laser. Scaling and root planing (SRP) was performed prior laser therapy. The protocol suggested by Parker et al. [3] for de-epithelisation of pocket lining was followed. Laser assisted pocket therapy was performed with a diode laser (Ezlase, Biolase, USA, 940 nm), using 400μ tip at 0.8W power in continuous mode. The procedure was performed only with topical anaesthesia using lidocaine spray (LOX 10% Spray). The tip was initiated prior use. It was inserted 1 mm short of the pocket depth such that the tip would remain in contact with the pocket wall at all times (Figure 12). The tip was used in contact mode and light sweeping motion apico-coronally. Each pocket site was treated for 20-30 seconds and the procedure was repeated at weekly intervals for 4 weeks. The patient was instructed to continue with routine tooth-brushing and advised 0.12% chlorhexidine mouthwash, twice daily for 1 month (PerioGard, Colgate). Re-evaluation after 3 months revealed pocket depth of 3mm and 5mm on the facial and mesial aspects respectively (Figure 13).

Figure 9 - Pre-operative view showing gingival hyperpigmentation.

Figure 11 - Preoperative view depicting a deep periodontal pocket with 11.

Figure 10 - Post-operative view after laser de-pigmentation.

Figure 12 - Laser disinfection of pocket with 11.

Case 6 (Dentinal hypersensitivity)

The sixth case was a 38 year old male patient, who complained of sensitivity with upper left back teeth that had developed after periodontal surgery. The patient was non-responsive to potassium nitrate containing desensitizing toothpaste and hence diode laser application was decided. The treatment protocol suggested by Umberto et al. [8] was followed. 1.25% sodium fluoride gel was applied to the teeth. The diode laser (Ezlase, Biolase, USA, 940 nm) was adjusted to power settings of 0.5 W and the tip was initiated. The laser was used in non-contact mode. The tip was held 2 mm away from the tooth surface and activated for 60 seconds. The beam was directed perpendicular to the tooth surface (Figure 14). Each site received a total of 3 applications, once a week for three weeks. The patient reported relief after the first session and was entirely symptom free after the completion of treatment. The patient was followed up after a period of three months and he did not report sensitivity with the treated tooth.

Figure 13 - Postoperative view depicting reduction in pocket depth with 11.

Figure 14 - Intra-operative view depicting laser irradiation for dentinal hypersensitivity.

DISCUSSION

In recent times, the diode laser has become popular because of its compact size, affordability, ease of use and versatility [9]. The use of diode laser for soft tissue surgery has been shown to have the following advantages - dry field, sterilization of the site and minimal post-operative pain, swelling or scarring [10-12]. Minimal bleeding occurs due to the sealing of small vessels by tissue protein denaturation as well as activation of clotting factor VII resulting in a dry surgical field [2]. The heat build-up which occurs with laser use results in sterilisation of the site [11]. The presence of surface coagulum prevents bacterial contamination and allows for a suture 'free' surgery. Li H et al in their histological study observed that laser treated sites exhibited better immune cell mobilization which also contributed to lesser post-operative infection [13].

Other advantages specific to periodontal therapy have also been mentioned by a few authors. Bhat et al. compared the tissue response post gingivectomy with scalpel or diode laser and observed that the soft tissue margins are more stable after laser excision whereas creeping was observed at 2 months post scalpel excision [14]. Gul et al. [15] in their systematic review and meta-analysis observed that diode laser resulted in better aesthetic outcomes after gingival depigmentation and was the modality of preference in terms of patient comfort and satisfaction as compared to other techniques. Jacob et al. [16] in their split mouth study found that operative ease was better and recurrence was lower in patients where diode laser was used for depigmentation. While Chandra et al. [17] observed that recurrence after depigmentation procedure was similar to scalpel technique in terms of reappearance duration and intensity up to 9 months post-operatively. A systematic review and meta-analysis conducted by Jia et al. [18] showed that the probing depth reduction was better when diode laser was used as an adjunct to scaling and root planing and the difference was significant even at 6 months follow –up.

Management of dentinal hypersensitivity with laser was also supported by a systematic review by Rezazadeh et al. [19] The authors stated that the combination of laser and densitizing agents worked better than densitizing agents alone not only for management and but also prevention of dentinal hypersensitivity.

According to the systematic review, application of laser resulted in immediate and long term relief from dentinal hypersensitivity similar to our observations in this case series. The diode laser thus offers several advantages such as reduced number of appointments due to avoidance of sutures, reduced bleeding at the surgical site and a disinfecting action. The procedures could have been performed using the conventional techniques but the authors chose diode laser owing to the above mentioned advantages. The use of diode laser also facilitated better patient satisfaction. This can be attributed to short operative time and better post-operative comfort in case of soft tissue surgeries and immediate relief in case of dentinal hypersensitivity.

At the same time a few disadvantages have also been reported. Due to the higher tissue penetration property of diode laser there is a risk of thermal damage to the pulp, root surface, periosteum and bone. A study by Ryu et al. [20] has also reported higher tissue damage with diode laser as compared to a scalpel via a profound inflammatory response. A recent histological study in mice depicted that the healing in tissue treated with laser was delayed as compared to the scalpel and this was attributed due to the thermal damage that occurs when laser is used at high power [13]. Amongst the cases described previously one patient exhibited delayed healing after laser assisted excision which can be attributed to inadvertent thermal damage to the underlying tissues.

The interactions of laser with tissue are not absolute and depend largely on the characteristics of recipient tissue. Because of these properties, there cannot be a fixed formula for use of diode laser but the available literature can be used as a template for performing various dental procedures. Following is a list of guidelines to prevent thermal damage to the tissues and undesirable outcomes after procedure:

a. Use of lower power settings – especially in inflamed and pigmented tissue as the diode laser is absorbed by tissue pigments like haemoglobin and melanin [2];
b. Use of Pulse mode for surgical purpose as it allows for cooling in between intervals and prevents thermal build-up [2];
c. Rapid movement of the laser beam to prevent heat build-up [2];
d. Avoiding direct contact with the root surface/bone surface at all times[2];
e. In the cervical region, do not position the fibre tip perpendicular to cervical surface, positioning it at 60 or 45 degrees to minimize direct heating of the pulp.
f. Use of exogenous coolants such as air/water to minimize thermal damage [2];
g. Use of gauze soaked in saline solution to help reduce temperature;
h. Activation of the fibre tip with carbon paper and keeping tissue residuals warm to accelerate thermal effects during incision procedures. Take care not to overheat the fibre tip and cause damage;
i. Cleaving the fibre tip after it becomes blackened or with excess accumulation of overheated tissues (2-4 mm from the tip). Excess of tissue debris accumulate on the tip during surgery and this causes the fibre tip to retain extreme heat which in turn can lead to unwanted tissue heating [12];
j. Directing the beam towards the discard tissue [7].

CONCLUSION

Thus, one should remember that diode laser is not synonymous to a magic wand and benefits can only be obtained only when the correct parameters are used. This paper presents both surgical and non-surgical applications of diode laser in periodontal therapy along with the technical protocol. In addition, clinical protocols have been put forth which can be followed for obtaining optimal benefits.

Authors' Contributions

PVB, MRK: clinical cases, writing of manuscript. SBS: supervision, manuscript review and editing.

Conflict of Interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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Regulatory Statement

All procedures were performed with prior informed consent from the patient.

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