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THE EFFECT OF PERIODONTAL LASER THERAPY ON GINGIVAL HEALING FOLLOWING ORTHODONTICALLY INDUCED GINGIVAL ENLARGEMENT

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Abstract

Introduction: Gingival enlargement is a very common problem, especially after orthodontic treatment. The aim of this study was to assess the healing process of gingival enlargement in adolescents with and without fixed orthodontic appliances following periodontal treatment and to evaluate the clinical response associated with laser-assisted gingival surgery. **Materials and Methods: A total of 60 individuals participated in the study.** Test Group 1 (T1- 20 individuals) consisted of individuals with gingival enlargement after orthodontic treatment who underwent Er,Cr:YSGG laser gingivectomy and gingivoplasty; Test Group 2 (T2- 20 individuals) consisted of individuals with gingival enlargement after orthodontic treatment who underwent gingivectomy and gingivoplasty with conventional hand instruments; and Control Group (K- 20 individuals) consisted of individuals with gingival enlargement without orthodontic treatment who underwent Er,Cr:YSGG laser gingivectomy and gingivoplasty. Patients with fixed orthodontic appliances constituted the test group. All participants were healthy, non-smokers, and 12–18 years of age, with gingival enlargement primarily affecting the labial surfaces of the anterior teeth. Clinical periodontal parameters, including plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing pocket depth (PPD), and gingival overgrowth index (GOI), were evaluated at baseline and on days 1, 30, and 90 after treatment. **Results:** All groups demonstrated improvements in periodontal parameters during follow-up. The T1 and C groups showed a rapid postoperative reduction in BOP and a marked reduction in GOI compared with baseline. Differences between groups became less pronounced during subsequent follow-up, and several parameters were similar by day 30 and day 90. The clinical observations suggest that laser-assisted gingival surgery can be a useful treatment option for gingival enlargement in adolescents receiving fixed orthodontic treatment. **Discussion:** The apparent advantages include effective tissue management, hemostasis, limited postoperative discomfort, and favorable early healing. The findings also emphasize that laser treatment should be considered an adjunct to, rather than a substitute for, meticulous plaque control and professional periodontal maintenance. **Conclusions:** Because the present study included a relatively small sample and had limitations in group comparability and follow-up duration, larger prospective studies with standardized treatment protocols are required to confirm the findings and establish the long-term periodontal benefits of laser therapy in orthodontic patients.

Keywords: Er,Cr:YSGG laser; Orthodontic Treatment; Gingival Enlargement; Gingivectomy; Adolescents.

1. INTRODUCTION

Gingival enlargement is a clinically important soft-tissue response that may develop during fixed orthodontic treatment. Although the placement of orthodontic brackets and bands does not necessarily produce periodontal disease by itself, the presence of fixed appliances can substantially alter the local environment around the gingival tissues [1]. Brackets, archwires, bands, and other components can increase plaque-retentive

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surfaces, interfere with access for toothbrushing and interdental cleaning, and make professional plaque removal more difficult. Consequently, inflammatory changes may become established rapidly in susceptible patients [2]. Gingival enlargement may be clinically evident as increased gingival volume, swelling, changes in gingival contour, and extension of gingival tissue over portions of the clinical crown [3].

The clinical importance of gingival enlargement extends beyond its appearance. Excessive gingival tissue can interfere with plaque control and can therefore create a self-perpetuating cycle in which inflammation promotes enlargement and enlargement facilitates further plaque retention. In adolescents, this problem can be particularly relevant because oral-hygiene performance may be inconsistent and motivation may vary considerably during orthodontic treatment [4]. In addition, changes in gingival contour may compromise smile aesthetics, alter the apparent length of the teeth, and in more pronounced cases interfere with mastication or lip posture. The original manuscript notes that excessive tissue growth may be associated with functional and aesthetic concerns, including lip protrusion and chewing difficulties. These consequences support the importance of early identification and appropriate periodontal management [5,6].

Gingival enlargement may arise from inflammatory, fibrotic, drug-associated, hereditary, or other etiologic factors. Inflammatory enlargement is generally associated with increased vascularity, inflammatory-cell infiltration, and tissue edema. By contrast, more fibrotic forms of enlargement involve a greater cellular and connective-tissue component and may not resolve completely with removal of local inflammatory factors alone [7]. The clinical distinction between gingival hypertrophy and hyperplasia is relevant because the response to nonsurgical periodontal therapy can differ. The source manuscript emphasizes that edema associated with gingival hypertrophy may improve following scaling, root planing, and plaque control, whereas persistent hyperplastic tissue may require surgical correction [8].

Orthodontic treatment can complicate this distinction because plaque accumulation around brackets may maintain a chronic inflammatory stimulus. Gingivitis is clinically characterized by redness, swelling, and increased bleeding on probing. In many patients these changes are reversible when the microbial biofilm is effectively controlled. However, when gingival enlargement persists after adequate nonsurgical therapy, surgical recontouring may be indicated [8]. Conventional gingivectomy and gingivoplasty remain established methods for removing excessive gingival tissue and restoring a more physiologic contour. Nevertheless, conventional surgery can be associated with intraoperative bleeding, the need for local anesthesia, postoperative discomfort, and concerns related to the management of the surgical field, particularly in young patients [9].

The use of dental lasers in periodontal soft-tissue procedures has therefore attracted considerable interest. Lasers may provide several practical advantages during gingival surgery, including improved hemostasis, reduced mechanical trauma, and a relatively clean operative field. The Er,Cr:YSGG laser has been used in a range of oral soft- and hard-tissue applications, including gingival resection, gingivoplasty, biopsy procedures,

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frenectomy, and crown-lengthening procedures [10]. In periodontal practice, the ability to ablate or reshape soft tissue while simultaneously controlling bleeding may be especially useful when the treatment site is close to orthodontic brackets and archwires [11].

The biological rationale for laser-assisted treatment is not limited to tissue removal. The clinical course of a periodontal wound depends on the control of bleeding, stabilization of the wound environment, protection of the treated area, and maintenance of adequate oral hygiene. A treatment approach that facilitates hemostasis and reduces postoperative discomfort may encourage adolescents to resume effective oral-hygiene procedures earlier [10,12]. This is potentially important in orthodontic patients because interruption of oral hygiene during healing can result in renewed plaque accumulation and inflammation. Therefore, the clinical success of laser therapy should be interpreted in conjunction with patient cooperation and periodontal maintenance rather than as an isolated effect of the laser itself [12]. The present study was designed to compare periodontal healing following laser-assisted treatment in orthodontic patients with the clinical course following conventional periodontal treatment in patients without fixed orthodontic appliances. The principal clinical outcomes were PI, GI, BOP, PPD, and GOI, assessed at baseline and during a 90-day follow-up. The study hypothesis was that laser-assisted excision of gingival enlargement would be associated with improved postoperative periodontal parameters, reduced bleeding and gingival overgrowth, and favorable patient comfort. The study also considered the possibility that the presence of fixed orthodontic appliances might influence healing and periodontal maintenance.

2. MATERIALS AND METHODS

Patients

This clinical study included 40 patients with gingival enlargement. Participants were divided into treatment groups according to the presence or absence of fixed orthodontic appliances. The control group consisted of 20 patients without fixed orthodontic appliances who received mechanical periodontal treatment and conventional gingival surgery when indicated. The test group consisted of patients receiving fixed orthodontic treatment who were treated with laser-assisted gingivectomy and gingivoplasty following initial nonsurgical periodontal therapy. All participants were healthy, non-smokers, and between 12 and 18 years of age. Gingival enlargement was present on the labial surfaces of the anterior teeth. Patients were excluded if they had systemic conditions that could influence periodontal healing, were taking medications known to cause drug-associated gingival enlargement, or were pregnant or lactating. These criteria were intended to reduce the influence of systemic or pharmacological factors that might independently modify gingival tissue response.

Ethical Approval and Specimen Source

The study was conducted following approval by the university's Human Ethics Research Committee. Participants and their parents or legal guardians were informed about the study procedures, and written consent was obtained. The investigation was conducted in

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accordance with the principles of the World Medical Association Declaration of Helsinki for medical research involving human subjects. Initial periodontal therapy was performed for all participants before the surgical phase. Scaling and root planing were carried out using periodontal scalers and curettes. Oral-hygiene instructions were provided, with emphasis on effective plaque removal and the specific difficulties associated with orthodontic appliances where applicable. Plaque scores were evaluated during the initial periodontal sessions. Professional dental prophylaxis and motivational oral-hygiene sessions were provided during a 30-day period. This preliminary phase was important because persistent gingival enlargement was considered for surgical treatment only after an attempt had been made to control the local inflammatory component. Following completion of the initial periodontal therapy, the participants were reevaluated. Periodontal charting was repeated, and persistent gingival enlargement was identified as the principal clinical indication for surgical intervention. This approach allowed the investigators to distinguish tissue enlargement that could respond to improved plaque control from enlargement that remained despite initial periodontal therapy.

Laser Treatment

Patients were assigned to the treatment groups described in the original protocol. In the laser-treated test group, gingivectomy and gingivoplasty were performed as an adjunct to nonsurgical periodontal treatment. A Waterlase MD laser system (Biolase Technology, Inc., Irvine, CA, USA) equipped with an MZ5 tip was used. The reported operating parameters were 1.5 W power, air/water settings of 40%/50%, and a pulse rate of 30 Hz. These parameters were applied for the treatment of the enlarged gingival tissue. After tissue removal and contouring, hemostasis was assessed before the patient left the clinical setting. The control group received conventional gingivectomy and gingivoplasty without fixed orthodontic appliances. The use of conventional surgical treatment in this group provided a clinical comparison for the laser-treated orthodontic group. Postoperative instructions were provided to all participants. Acetaminophen was prescribed for pain control according to the original protocol. The study reports that no clinically significant discomfort or pain was experienced during or after laser treatment. Clinical periodontal measurements were performed by the same periodontist. The examiner was unaware of the treatment method to minimize measurement bias. The following clinical parameters were recorded: Plaque Index (PI), Gingival Index (GI), Bleeding on Probing (BOP), Probing Pocket Depth (PPD), and Gingival Overgrowth Index (GOI). Measurements were obtained at baseline and at postoperative days 1, 30, and 90. The repeated assessment schedule was selected to characterize both the immediate postoperative response and the subsequent short-term healing course.

PI was used to evaluate the level of plaque accumulation. This parameter was particularly relevant because plaque is a major local factor associated with orthodontically induced gingival inflammation. GI was used to characterize the severity of gingival inflammation, while BOP provided an additional clinical indicator of inflammatory activity. PPD measurements were included to determine whether treatment produced clinically

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detectable changes in probing depth. GOI was used to assess the degree of gingival enlargement and to quantify changes in gingival tissue contour during healing.

Statistical Analysis

The statistical analysis was performed using SPSS Statistics version 19.0.0 (SPSS Inc., Chicago, IL, USA). Changes in periodontal parameters over time were analyzed using repeated-measures analysis of variance. Intragroup comparisons between baseline and postoperative measurements were performed using paired t-tests, and intergroup comparisons were conducted using Student's t-test. Statistical significance was established at $P < 0.05$.

3. RESULTS

The study included 60 participants, of whom 32 were female and 28 were male. The reported mean age was 12.10 ± 3.2 years. The periodontal parameters demonstrated an overall improvement during the follow-up period. The changes were most apparent in the parameters reflecting gingival inflammation and gingival tissue enlargement. These findings indicate that both the initial periodontal treatment and the subsequent management of persistent gingival enlargement were associated with clinical improvement.

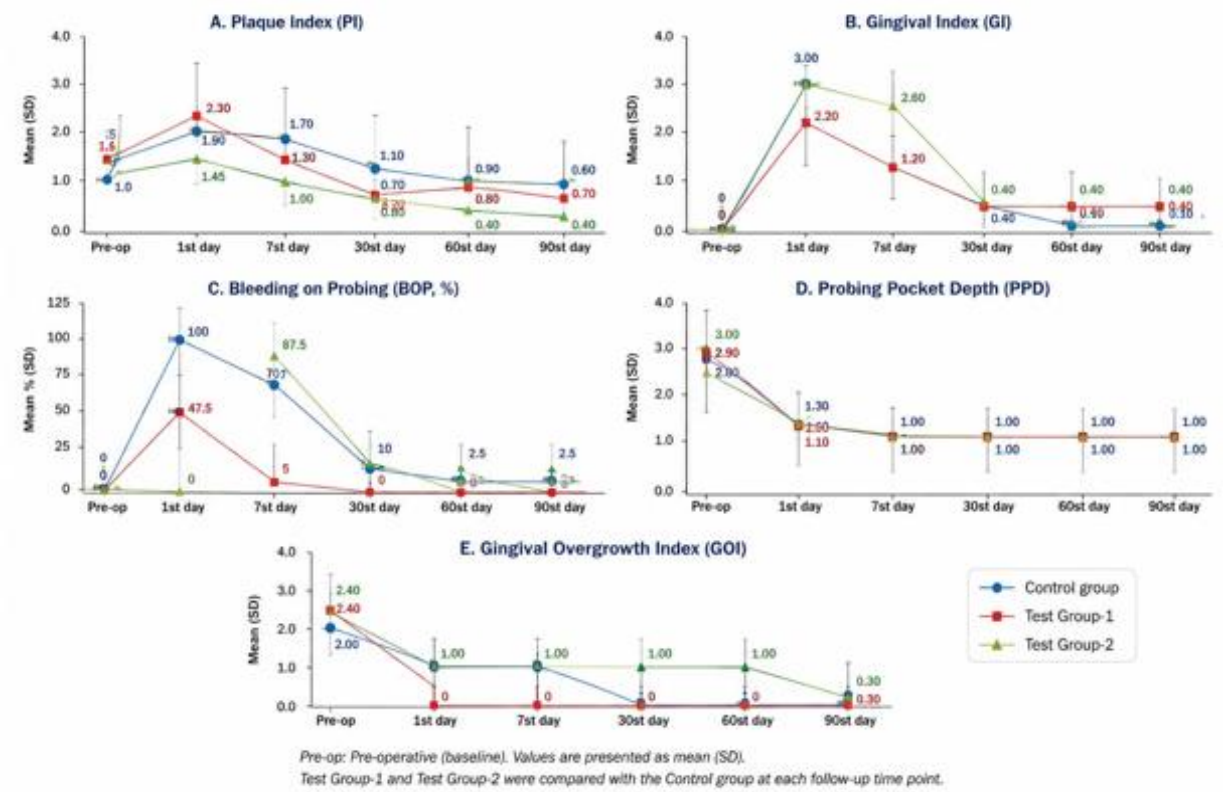


Figure 1: Longitudinal Changes in Periodontal Parameters across Different Follow-up Time Points

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Table 1: Longitudinal Evaluation of Clinical Periodontal Parameters Following Treatment

Parameter	Follow-up	Control group	Test Group-1	Test Group-2	p-value
PI	Pre-op	1.02 (0.02)	1.42 (0.44)	1.52 (0.50)	<0.05
PI	1st day	1.92 (1.01)	2.32 (0.44)	1.47 (0.89)	<0.05
PI	7st day	1.70 (0.40)	1.30 (0.76)	1.03 (0.34)	>0.05
PI	30st day	1.13 (0.66)	0.74 (0.33)	0.81 (0.44)	>0.05
PI	60st day	0.93 (0.26)	0.84 (0.25)	0.43 (0.11)	>0.05
PI	90st day	0.64 (0.12)	0.71 (0.13)	0.41 (0.11)	>0.05
GI	Pre-op	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	<0.05
GI	1st day	2.93 (0.02)	2.14 (0.34)	2.92 (0.02)	>0.05
GI	7st day	1.70 (0.34)	1.13 (0.23)	2.47 (0.49)	<0.05
GI	30st day	0.41 (0.18)	0.40 (0.14)	0.40 (0.22)	>0.05
GI	60st day	0.13 (0.14)	0.41 (0.16)	0.44 (0.04)	<0.05
GI	90st day	0.13 (0.14)	0.44 (0.06)	0.32 (0.06)	<0.05
BOP	Pre-op	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	>0.05
BOP	1st day	100.02 (0.02)	62.52 (6.77)	0.02 (0.02)	<0.05
BOP	7st day	90.02 (15.02)	10.02 (1.82)	100.02 (20.02)	<0.05
BOP	30st day	20.02 (3.02)	0.02 (0.02)	15.02 (2.02)	<0.05
BOP	60st day	2.42 (0.84)	0.02 (0.02)	2.42 (0.92)	<0.05
BOP	90st day	3.02 (0.87)	0.02 (0.02)	0.02 (0.02)	<0.05
PPD	Pre-op	2.78 (0.63)	2.86 (0.36)	3.01 (0.34)	>0.05
PPD	1st day	1.31 (0.40)	1.13 (0.32)	1.34 (0.34)	>0.05
PPD	7st day	1.02 (0.02)	1.02 (0.49)	1.02 (0.02)	>0.05
PPD	30st day	1.02 (0.02)	1.02 (0.02)	1.02 (0.02)	>0.05
PPD	60st day	1.02 (0.02)	1.02 (0.02)	1.02 (0.02)	>0.05
PPD	90st day	1.02 (0.02)	1.02 (0.02)	1.02 (0.02)	>0.05
GOI	Pre-op	2.03 (0.44)	2.34 (0.78)	2.40 (0.80)	<0.05
GOI	1st day	1.02 (0.02)	0.02 (0.02)	1.02 (0.02)	<0.05
GOI	7st day	1.02 (0.02)	0.02 (0.02)	1.02 (0.02)	<0.05
GOI	30st day	0.02 (0.02)	0.02 (0.02)	1.02 (0.02)	<0.05
GOI	60st day	0.02 (0.02)	0.02 (0.02)	1.02 (0.02)	<0.05
GOI	90st day	0.02 (0.02)	0.29 (0.12)	0.31 (0.16)	<0.05
Values are presented as Mean (SD).					

The table presents the mean changes in plaque index, gingival index, bleeding on probing, probing pocket depth, and gingival overgrowth index across multiple follow-up time points. Comparisons among the control, Test Group-1, and Test Group-2 demonstrate the temporal pattern of periodontal changes throughout the 90-day follow-up period.

Plaque Index showed postoperative changes during follow-up. On the first postoperative day, the reported difference in PI between the control and test groups was not statistically significant. The lack of a significant immediate difference is clinically understandable because plaque accumulation is primarily influenced by oral-hygiene behavior and the mechanical environment rather than by the surgical modality alone. In orthodontic patients, brackets and wires remain potential plaque-retentive factors even after successful removal of excessive gingival tissue.

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Consequently, continued oral-hygiene instruction and professional maintenance remain essential throughout treatment (Table-1, Figure-1).

The GI findings demonstrated an early difference between treatment groups. The original results report that the increase in GI in the laser-treated test group was significantly lower than that observed in the comparison groups on postoperative day 1. During the first month, the test group showed a slower recovery pattern for GI, although by the end of the first month the GI values were similar among the groups. At 90 days, the control group demonstrated the lowest GI level, but the difference was not statistically significant. These observations suggest that the early inflammatory response following laser treatment was favorable, while longer-term gingival inflammation became increasingly dependent on factors other than the surgical method (Table-1, Figure-1).

BOP provided one of the most clinically notable early findings. In the laser-treated test group, BOP decreased by approximately one-half on the first postoperative day, whereas the comparison group was reported to remain at 100% at that time point. By day 30, no statistically significant difference in BOP remained between groups. The rapid early reduction in BOP is consistent with the hemostatic characteristics expected during laser-assisted soft-tissue surgery. Nevertheless, because BOP is also strongly influenced by plaque accumulation and tissue inflammation, the disappearance of the intergroup difference during later follow-up suggests that maintenance of periodontal health cannot be attributed solely to the initial surgical intervention (Table-1, Figure-1).

No significant changes in PPD were observed between the groups during the treatment period. This finding is relevant because the principal purpose of the surgical procedure was removal and reshaping of excessive gingival tissue rather than periodontal pocket elimination. The absence of a significant PPD difference indicates that the treatment did not result in a clinically meaningful alteration in probing depth during the observed follow-up period (Table-1, Figure-1).

GOI showed a marked response to treatment. Gingival overgrowth was generally more pronounced in patients with fixed orthodontic appliances, consistent with the plaque-retentive characteristics of orthodontic appliances and the inflammatory environment associated with them. The decrease in GOI was described as significant and markedly greater in the laser-treated test group. By day 30, however, GOI levels had become similar among the groups. At day 90, the control group had lower GOI values, but this difference was not statistically significant (Table-1, Figure-1).

Taken together, the results indicate that the principal benefit associated with laser treatment was an early and pronounced improvement in gingival tissue condition and bleeding, particularly in the orthodontic group. The later convergence of clinical parameters suggests that the initial surgical approach may influence the speed of healing without necessarily producing large differences in periodontal status after several months. This interpretation is particularly important in orthodontic patients because the continuing presence of fixed appliances may remain a determinant of plaque accumulation and gingival inflammation throughout the course of treatment.

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4. DISCUSSION

The management of gingival enlargement during orthodontic treatment presents a clinical challenge because the underlying inflammatory stimulus may persist as long as plaque control remains difficult. Fixed orthodontic appliances create numerous plaque-retentive areas around brackets, bands, archwires, and other components. Even patients with adequate motivation may have difficulty achieving the level of plaque removal required to maintain gingival health [5]. The principal finding was that laser-assisted treatment was associated with rapid clinical improvement in several periodontal parameters. The most pronounced early responses were observed in BOP and GOI. These observations are compatible with the proposed clinical advantages of laser-assisted soft-tissue surgery, particularly hemostasis and controlled tissue removal. In conventional gingivectomy, bleeding from the highly vascular gingival tissues can obscure the operative field and may complicate tissue contouring. A laser can provide simultaneous tissue ablation and coagulation, potentially allowing the clinician to visualize and sculpt the gingival margin more effectively [7].

The early reduction in BOP in the test group is especially noteworthy. The reported reduction by approximately one-half on the first postoperative day contrasts with the 100% BOP reported in the comparison group at the same time point. Although BOP should not be interpreted as a direct measure of surgical hemostasis, it reflects the clinical inflammatory and bleeding response of the gingival tissues. The finding is consistent with the practical observation that laser treatment can reduce bleeding during soft-tissue procedures and may facilitate early wound stabilization [10,11].

The GOI findings provide additional evidence for the effectiveness of laser-assisted tissue removal. The test group showed a marked decrease in gingival overgrowth, even though these patients had fixed orthodontic appliances and therefore continued to experience an environment that favors plaque retention [11]. This point is clinically important. If excessive tissue is removed but the local plaque-retentive environment is not controlled, recurrence may occur. The observed improvement should therefore be interpreted as the result of a treatment sequence consisting of initial periodontal therapy, oral-hygiene instruction, surgical removal of persistent enlargement, and continued follow-up [10].

The absence of a significant difference in PPD deserves consideration. Gingival enlargement can produce apparent increases in probing depth without necessarily indicating destructive periodontal disease. Removal of excess tissue may alter gingival contour without producing a measurable change in the underlying periodontal attachment apparatus [13]. The lack of a significant PPD difference during follow-up therefore suggests that the principal clinical benefit of the intervention was soft-tissue correction and inflammation control rather than a change in periodontal probing characteristics [14].

The PI findings emphasize a central point in orthodontic periodontal care: surgical treatment cannot replace plaque control. The first postoperative evaluation did not demonstrate a significant difference in PI between the groups. This is important because the laser does not remove the source of plaque accumulation associated with fixed

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orthodontic appliances. Even when gingival tissue has been successfully recontoured, brackets and wires remain present and can continue to favor biofilm accumulation. Thus, the long-term periodontal outcome depends heavily on patient adherence to oral-hygiene instructions and on professional maintenance [15].

The temporal pattern of GI further illustrates the importance of considering both short-term and longer-term outcomes. The laser-treated group demonstrated a favorable early response, but by approximately one month the values were similar among groups. At three months, the control group had numerically lower GI values, although the difference was not statistically significant. This convergence may indicate that the initial benefit of the laser is greatest during the immediate healing period, whereas subsequent periodontal health is increasingly influenced by oral hygiene, the orthodontic environment, and individual susceptibility to gingival inflammation [12,13].

The findings are broadly consistent with earlier reports concerning laser treatment of orthodontically induced gingival enlargement. Convissar and colleagues described the use of Nd and CO2 lasers in cases of orthodontically induced gingival hyperplasia and reported favorable hemostasis, limited postoperative discomfort, and satisfactory esthetic outcomes. Their observations support the concept that laser-assisted surgery can be particularly useful when gingival enlargement occurs in conjunction with orthodontic appliances [10-12].

Aboelsaad and Attia evaluated diode laser treatment in a randomized controlled clinical trial involving 38 patients and concluded that diode laser gingivectomy could rapidly resolve gingival overgrowth and provide better control of gingival inflammation than nonsurgical periodontal treatment alone at 12 weeks. Although the laser system used in that investigation differed from the Er,Cr:YSGG system used in the present study, the clinical principle is comparable: controlled laser-assisted removal of excessive gingival tissue may facilitate the management of persistent enlargement when nonsurgical treatment is insufficient [13].

Similarly, To and colleagues investigated diode laser gingivectomy as an adjunct during orthodontic treatment. Their study assessed PI, GI, BOP, PPD, and GOI at baseline and during follow-up and reported earlier and more substantial improvements in gingival health in the laser-treated orthodontic group [14]. The similarity between the periodontal variables used in that investigation and those used in the present study strengthens the clinical relevance of the current observations, while differences in laser type, treatment protocol, sample characteristics, and follow-up duration should be acknowledged [15].

The Er,Cr:YSGG laser has characteristics that make it attractive for soft-tissue applications. In the present study, the Waterlase MD system was used with an MZ5 tip at 1.5 W, 40% air, 50% water, and 30 Hz. The water component is relevant to the clinical operation of this laser system and may contribute to thermal management during tissue treatment [17]. The clinician can therefore perform controlled tissue removal while attempting to minimize undesirable thermal effects. However, laser parameters are system- and procedure-dependent, and the settings used in this study should not

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automatically be generalized to every clinical situation. An interesting practical observation was that the laser system did not produce the unpleasant smell of burning tissue that can occur with some other laser systems. The absence of an unpleasant odor was reported as a positive experience for both patients and clinicians. Patient perception is an underappreciated component of pediatric and adolescent dentistry [18]. Even when a procedure is clinically straightforward, sensory experiences such as odor, heat, noise, bleeding, and postoperative discomfort may influence anxiety and future treatment acceptance. A procedure that is perceived as more comfortable may facilitate cooperation with periodontal treatment and subsequent orthodontic appointments [10].

The relationship between periodontal and orthodontic care is particularly important in adolescents. Periodontal inflammation can complicate orthodontic treatment, while orthodontic appliances can complicate periodontal maintenance. A coordinated approach between the periodontist and orthodontist can therefore improve treatment planning. Before orthodontic therapy, patients should ideally receive a periodontal assessment and any active periodontal inflammation should be controlled [19,20]. During orthodontic therapy, regular monitoring can identify gingival enlargement at an early stage. If enlargement becomes persistent, intervention can be performed before the tissue becomes more extensive and more difficult to manage. The current findings suggest that the presence of fixed appliances does not prevent favorable healing after laser-assisted gingival surgery [16,18].

Indeed, the principal limitation of the study is the difference between treatment groups in more than one variable. The test group had fixed orthodontic appliances and received laser treatment, whereas the control group did not have fixed appliances and received conventional surgery. Consequently, differences between groups may reflect the effect of the laser, the effect of orthodontic appliances, differences in baseline gingival condition, or an interaction between these factors. The sample size is another limitation. Participants provide preliminary clinical information but are insufficient for definitive conclusions about the superiority of one treatment modality. A larger sample would increase statistical power and allow more reliable subgroup analysis. It would also permit evaluation of potentially relevant variables such as sex, age, severity of gingival enlargement, oral-hygiene status, orthodontic treatment duration, and baseline periodontal indices.

The follow-up period of 90 days is useful for evaluating early and short-term healing but does not establish long-term stability. Gingival enlargement in orthodontic patients can recur if plaque control deteriorates or if local contributing factors persist. Longitudinal studies extending throughout the orthodontic treatment period would provide more clinically meaningful information about recurrence, maintenance of gingival contour, and periodontal health.

The study also relied on clinical periodontal measurements without adjunctive microbiological or biochemical assessment. The biological mechanisms underlying gingival enlargement and healing could be explored more thoroughly by evaluating plaque-associated microorganisms, inflammatory mediators, or markers of tissue remodeling. Histological assessment could also help determine whether laser-assisted

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treatment produces differences in epithelialization, connective-tissue organization, inflammatory infiltration, or collagen remodeling. Such analyses would provide mechanistic support for the clinical observations.

The study further supports the importance of frequent periodontal monitoring during orthodontic treatment. Patients with fixed appliances should receive reinforcement of oral-hygiene instructions throughout treatment rather than only at appliance placement. Shorter recall intervals may be appropriate for patients who demonstrate recurrent plaque accumulation or gingival enlargement. Professional prophylaxis can be used to maintain gingival health and to prevent minor inflammatory changes from progressing to persistent tissue enlargement.

5. CONCLUSION

Within the limitations of this clinical study, laser-assisted gingivectomy and gingivoplasty appear to be a useful treatment option for persistent gingival enlargement in adolescents undergoing fixed orthodontic treatment. The laser-treated group demonstrated rapid improvements in bleeding and gingival overgrowth, together with favorable early healing characteristics and good reported patient comfort. During longer follow-up, differences between treatment groups became less pronounced, emphasizing that sustained periodontal health depends on effective plaque control and professional maintenance. The results suggest that laser-assisted periodontal surgery can provide favorable early healing characteristics in adolescents with orthodontically associated gingival enlargement. The strongest observed effects were related to bleeding and gingival overgrowth, while differences in gingival inflammation became less pronounced during longer follow-up. The findings are compatible with previous clinical reports of laser-assisted treatment and support further investigation of Er,Cr:YSGG laser therapy in orthodontic patients. Nevertheless, the limitations of the present study mean that the results should be considered preliminary rather than definitive evidence of superiority over conventional surgery.

Laser therapy should therefore be regarded as an adjunctive surgical approach within a comprehensive periodontal treatment protocol. Initial nonsurgical periodontal therapy and oral-hygiene instruction remain essential, and persistent enlargement should be treated surgically only when clinically indicated. Larger randomized controlled trials using equivalent orthodontic populations, standardized laser and conventional surgical protocols, validated patient-reported outcomes, and longer follow-up are needed to determine whether laser treatment provides a clinically meaningful long-term advantage over conventional gingivectomy in orthodontic patients.

Statements

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Ethics statement

The studies involving humans were approved by Research Ethics Committee of the University of Medicine and Pharmacy at Van Yuzuncu Yıl. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

Conceptualization: [BYE, NO, ASE]; Methodology: [BYE, NO, ASE]; Investigation and data collection: [BYE]; Formal analysis: [BYE]; Data curation: [BYE]; Writing – original draft: [BYE, NO]; Writing – review and editing: [BYE, NO, ASE]; Supervision: [BYE, NO, ASE]; Project administration: [BYE, NO, ASE]; Funding acquisition: [BYE, NO, ASE].

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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