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Evaluation of 940 nm Diode Laser in Esthetic Crown Lengthening

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Abstract Background: Crown lengthening is a surgical procedure that apically positions the gingival edge and/or removes supporting bone in order to increase the amount of supra gingival tooth structure for restorative or cosmetic purposes.

The objective of the study: The purpose of this study was to evaluate the efficacy of the 940nm diode laser in esthetic crown lengthening surgery through clinical observations, patient questionnaires, clinical photographs, and gingival healing following gingival operations. **Material and methods**: In this randomized clinical trial, 16 patients (11 females and 5 males) had their crowns surgically lengthened using a diode laser (940 nm) in continuous wave (CW) mode with 1 watt energy settings. A visual analogue scale is used on the first, third, seventh, and twenty-first days following surgery to record pain, swelling, bleeding, functional interference, tooth sensitivity, and success from an aesthetic standpoint, as well as overall patient satisfaction based on patient opinion and clinical photographs. **Results**: In the present study, we noticed that the scale of pain, bleeding, oedema, function interferance, and tooth sensitization significantly decreased gradually during the first two visits. The measured parameters completely disappeared after one week in most cases, as well as increase patient satisfaction and aesthetic achievement. The patients were recalled three weeks later, the wounds had totally healed, and the patient were not complaining of any pain. **Conclusion**: Crown lengthening requires optimal gingival margin design. This involves precise shaping of delicate tissues, which is difficult with the scalpel. While Lasers give improved gingival sculpting control and can be used for aesthetic crown lengthening. The laser surgery has many advantages, including excellent hemostasis with little or no bleeding, being less invasive and sterile wound cut, causing less pain and suffering during and after surgery, and enhancing patient satisfaction since the operation is short and, in most circumstances, relatively painless. Also, in laser surgery, there is less functional interruption and enhanced patient satisfaction since a periodontal pack is not needed to cover the surgery site. The healing is faster and more aesthetic when using laser surgery procedure.

Keywords: diode laser, esthetic, crown lengthening, scalpel surgery, laser surgery, visual analogue scale (vas)

Introduction

A pleasing smile is seen as a symbol of attractiveness in modern society (Cairo et al., 2012). A beautiful smile is influenced by the hard tissue components (such as teeth), the degree of gingival appearance, and the lip shape (Manjula et al., 2015). Gingival health is one of the primary fundamental aesthetic goals to take into account when formulating a treatment plan. Additionally important are the gingiva's margin and shape. The remaining ridges of the maxilla and mandible in the oral cavity are covered by the keratinized epithelium known as gingiva, which also extends to the mucogingival junction in the vestibule (Wahyuni et al., 2021).

Crown lengthening is a surgical procedure that lengthens the supragingival tooth structure. A gingivectomy, also referred to as crown lengthening, is a surgical procedure that involves removing and reforming the gingival margin in order to achieve aesthetic, functional, or restorative objectives (Nield-Gehrig and Willmann, 2007). Several surgical techniques that all attempt to improve the appearance of the gingiva and teeth may be used to extend crowns. When reshaping the marginal gingiva, care must be taken to preserve the biologic width. Sometimes osseous recontouring is needed to keep the biologic width and place the margins correctly (Shivaprasad et al., 2015).

Crown lengthening surgery was esthetic or functional, depending on the patient. "Esthetic crown lengthening" refers to increasing the length of the tooth structure for aesthetic purposes, such as in the case of patients with short clinical crowns and gummy smiles related to altered passive eruption; while "restorative/functional crown lengthening" refers to exposing a fractured tooth or sub gingival caries (Hempton and Dominici, 2010). Crown lengthening procedures that are both practical and aesthetically are recommended in several clinical situations (Farista et al., 2016). Crown lengthening is utilized for excessive gingival exposure, a "gummy smile," from inadequate passive eruption, or "short teeth." Short clinical crowns are teeth with fewer than 2 mm of sound, opposing parallel walls following occlusal and axial reduction (Rabie et al., 2013). Crown lengthening may be performed using a scalpel, electrosurgery, or a laser.

Compared to other technologies, lasers provide various advantages. laser therapy is effective and produces good outcomes and patient satisfaction. The mechanism of the laser's action on tissue is determined by the laser settings and the properties of the tissue. Different types of lasers are used in periodontal surgery, including Nd:YAG, diode, CO2, and the Erbium laser family (Musaa et al., 2017). Due to the many benefits of lasers, they rapidly gained a significant role in dentistry, especially soft tissue lasers for oral surgery, which are progressively preferred over traditional techniques due to their good hemostasis, accessibility of the wound area, reduced edema, very limited area of thermal necrosis in surrounding tissues, reduced post-operative pain, and potential to perform operations without anesthesia (Al-Jumaily, 2019).The diode laser is one of the most commonly used laser systems. It is mostly utilized in soft tissue applications. In this randomized clinical trial, using a diode laser (940 nm) in continuous wave (CW) mode with 1 watt energy settings for aesthetic crown lengthening.

Material and methods

Sixteen people between the ages of 15 and 42 participated in this study. They were either healthy or had a well-controlled systemic illness. The periodontal area must be in excellent health. This may be assessed by evaluating the gingival bleeding score, gingival inflammatory score, and gingival pocket probing depth. Also, another inclusion criteria involved patients who had gingival exposure between 4 and 6 mm due to a short clinical crown or an imbalance of

tooth length and gingival margins. as well as patients who require crown lengthening therapy due to gingival enlargement caused by prostheses, orthodontics, or after healing of periodontal disease, or plaque that induced gingival enlargement. Demographic information such as the patient's age and gender, medical and dental histories, clinical examination, and the number of teeth involved in the operation, which must be at least four, were collected. Aesthetic crown lengthening by gingivectomy was performed at the University of Baghdad, Faculty of Dentistry, Department of Periodontology, by using a 940 nm diode laser. All treatments were carried out after the patient was informed about the goal of this study and gave informed consent. All participants were given oral hygiene guidelines as well as phase I periodontal therapy at the beginning of the study. The patients' gingival contours were assessed after one week for aesthetic crown lengthening operations. Before scaling, the plaque index (pl), bleeding on probing, and gingival index (GI) were all calculated. Chu aesthetic gauges were used on patients who had gingival exposure when smiling as a result of incorrect passive eruption and a short clinical crown. Gauges were used as recommendations to identify the right occlusogingival clinical dimension of the tooth in proportion to its width and the correct papilla position in relation to its length. Postoperative pain, edema, bleeding, functional interference, tooth sensitivity, healing, aesthetic achievement, and patient satisfaction were assessed at 1, 3, 7, and 21 days. Postoperative parameters were measured using the visual analogue scale (VAS). The VAS scale is used to assess subjective feelings like pain and other discomforts. In the present study, researchers used a traditional VAS in which a dentist wrote a vertical sign ranging from 0 (no symptoms) to 3 (severe symptoms) (the highest degree of symptoms) at each postoperative appointment.

Procedure

Following the use of a periodontal probe to identify the cemento-enamel junction (CEJ), the surgical region was anesthetized with enough infiltration. The alveolar bone height and the position of supra-crestal soft tissues are both determined by the bone-souning procedure. By placing a periodontal probe or Chu's bone sounding gauges into the sulcus, mark the bleeding areas using a pocket depth indicator. After initializing the fiber tip in contact mode, use sweeping brushing strokes and beveled incisions. The power was selected after the desired effect (excision of diseased tissue without tissue harm) was achieved using 1 W of 940 nm diode laser in continuous wave mode with a fiber-optic delivery system (fiber tip 400 μm). An assistant was instructed to maintain irrigation with normal saline to cool the tissue and clean the surgical site, as well as to keep the vacuum tips close to the operational site to suck up any smoke or odor that could result from laser tissue ablation. Wet gauze was used to clean the surgical site and tip. The laser was interrupted every 15 seconds to evaluate gingival tissue and minimize overheating. Aesthetic crown lengthening by laser technique with follow up assessment shown in figure (1).

Statistical analysis:

The data was entered into the SPSS V26 statistical program, and descriptive statistics were displayed in tables and graphs.

While the Friedman test was utilized to assess progress in the study's dependent parameters, P value 0.05 was regarded as the cutoff point of significance.

Fig. 1: (A) A preoperative perspective (B)intra-operative perspective, (C) immediate post-operative perspective, and (D) 3 days postoperatively (E) one week postoperative surgery (F) three-weeks post-operative perspective ,(G) after bleaching and direct filing treatment.

Results

This study included 16 participants (11 females and 5 men) who underwent surgical esthetic crown lengthening by diode laser (940nm). They ranged in age from 15 to 42 years old, with 37.8% being teenagers and 62.5% being adults. As shown table (1)

Table 1:distribution of studied cases based on the age and the gender of the participations

		N	%
Age	<20 year	6	37.5%
	=>20 year	10	62.5%
Gender	Male	5	31.3%
	Female	11	68.8%

The levels of pain, bleeding, swelling, functional interference (FI), and tooth sensitivity (TS) were significantly decreased throughout the time of measurement. according to the Fridman test, p value 0.05 for all circumstances, as shown in Table 2.
Healing, aesthetic accomplishment (AA), and satisfaction levels were found to be consistent and to have grown considerably throughout research phases.
P= 0.001 in all circumstances.

Table 2: The Friedman test demonstrates how pain, edema, bleeding, patient satisfaction, and function vary during an assessment

Variable	Time	Mean±std	Median (IQR)	Ranks	P value
Pain	1st day	1.06±0.68	1(.75)	2.78	0.001
	3rd day	0.13±0.34	.00	1.69	
	7th day	0.00	.00	1.53	
Bleeding	1st day	0.38(0.5)	1(1)	2.31	0.009
	3rd day	0.13(0.342)	1	1.94	
	7th day	0.00	0	1.75	
Edema	1st day	0.19	0	1.56	0.157
	3rd day	0.06	0	1.44	
FI	1st day	0.69±0.479	1(1)	3.47	0.001
	3rd day	0.13±342	0	2.34	
	7th day	.00	0	2.09	
Healing	1st day	.63±0.5	1(1)	1.44	0.001
	3rd day	1±0.	1(0)	1.81	
	7th day	1.88±0.5	2(0)	2.91	
	21st day	2.81±0.75	3(0)	3.84	
TS	1st day	0.38±0.619	0(1)	1.66	0.025
	3rd day	0	0	1.34	
AA	1st day	1.88±0.342	2(0)	1.41	0.001
	3rd day	2.19±0.544	2(0)	1.97	
	7th day	2.88±0.342	3(0)	3.31	
Satisfaction	1st day	2±0	2(0)	1.25	0.001
	3rd day	2.63±0.5	3(1)	2.50	
	7th day	2.94±0.25	3(0)	3.13	
	21st day	2.94±0.25	3(0)	3.13	

Table3: shows the patient distribution based on the scores of measured variables (pain, bleeding, edema, functional interference and healing) at the time of each patient's measurements. (R1= 1day, R2=3 days, R3=7 days, R4=21days)

	Pain				Bleeding				oedema				FI				Healing			
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
1	2	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1	2	3
2	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
4	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	2	3
5	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	2	3
6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3
7	2	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	1	2	3
8	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3
9	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
11	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	3
12	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	2	3
13	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3
14	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3
15	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3
16	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	2	3

Table 4: The distribution of studied patients based on measured variable scores (teeth sensitivity TS, aesthetic achievement AA and patient satisfaction) at the time of each patient's measurements.

(R1= 1day, R2=3 days, R3=7 days, R4=21days)

	TS				AA				Satisfaction			
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
1	0	0	0	0	2	2	3	3	1	2	3	3
2	1	0	0	0	2	2	3	3	1	2	3	3
3	0	0	0	0	2	3	3	3	1	3	3	3
4	0	0	0	0	2	2	3	3	1	3	3	3
5	1	0	0	0	2	3	3	3	1	2	3	3
6	0	0	0	0	2	2	3	3	1	3	3	3
7	2	0	0	0	1	2	3	3	1	2	3	3
8	0	0	0	0	2	2	3	3	1	3	3	3
9	0	0	0	0	2	2	3	3	1	3	3	3
10	0	0	0	0	2	3	3	3	1	3	3	3
11	0	0	0	0	2	3	3	3	1	3	3	3
12	0	0	0	0	1	1	2	2	1	2	3	3
13	0	0	0	0	2	2	3	3	1	2	2	3
14	1	0	0	0	2	2	3	3	1	3	3	3
15	1	0	0	0	2	2	2	2	1	3	3	3
16	0	0	0	0	2	2	3	3	1	3	3	3

Discussion

Esthetic crown lengthening is a secure and reliable way to maintain healthy dentogingival relationships. The laser may be utilized in place of conventional techniques for numerous intraoral soft tissue surgical operations. Crown lengthening has been performed using a variety of lasers, including Nd:YAG, Er, Cr:YSGG, Er:YAG, carbon dioxide, and diodes (Verma et al., 2012). Diode lasers may operate in continuous or pulsed mode and produce near-infrared laser light with a wavelength of 810 to 980 nanometers. These wavelengths are readily absorbed by hemoglobin and pigment, which make up the majority of soft tissue. Diode lasers may thus be used for incision, excision, coagulation, and pain treatment. This clinical study evaluated the efficiency of a 940nm diode in soft tissue crown lengthening. Postoperative pain, bleeding, oedema, functional interference, healing, tooth sensitivity, aesthetic accomplishment, and patient satisfaction were evaluated using visual analog scales. The data showed a considerable reduction in pain on the 1st and 3rd days, which disappeared on the 3rd (7 days) and 4th (21 days) visits. This is due to the laser's influence on prostaglandin production and its sealing action on nerve terminals (Abdulkareem et al., 2021). edema and bleeding scores were significantly decreased across time of treatment in laser due to the laser's ability to control bleeding during surgery by closing small blood vessels and blocking lymph vessels helps prevent post-operative issues such as swelling and edema. Over time, the functional interference score declined significantly. Since a coagulated layer develops over the surgical incision after laser surgery, there is no need to cover the surgical site with a periodontal pack. Laser treatment enhances wound healing by accelerating epithelial cell mobility and fibroblast proliferation. Immune cells like neutrophils and macrophages release cytokines and growth hormones during this period (Subramanya, 2022). The healing score increased with time in this study. Additionally, in this trial, the tooth sensitivity score decreased significantly with time. Aesthetic achievement was evaluated in this study. Participants responded significantly to esthetic improvements after a week because lasers coagulate tissue, making it easier to visualize the operative area directly after surgery. That made the

patient more satisfied throughout the treatment. In this investigation, the aesthetic accomplishment and patient satisfaction scores increased dramatically throughout treatment.

Conclusion

Esthetic crown lengthening is important to produce appropriate gingival margin morphology. This requires an accurate tissue incision, which is difficult with traditional (scalpel) treatments. Insufficient scalpel design for a smooth gingival margin curvature leads to uneven margins with tattered edges. The surgeon typically deviates from the original gingival margin design to minimize tissue scarring. Lasers allow more control over gingival sculpting and should be included in the aesthetic crown lengthening arsenal. Diode lasers are beneficial in respect of operator control, ease, and ablation accuracy.

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تقييم الدايود ليزر ذو الطول الموجي 940 نانومترفي إطالة التاج التجميلي

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الخلاصة الخلفية والمعلومات : إطالة التاج هو إجراء جراحي يتم فيه وضع حافة اللثة بشكل قمعي و/او ازالة العظام الداعمة من اجل زيادة كمية بنية الاسنان فوق اللثة للاغراض الترميمية او التجميلية.

الهدف من الدراسة: الهدف من هذه الدراسة هو تقييم فعالية ليزر الدايود 940 نانومتر في جراحة اطالة التاج التجميلي من خلال الملاحظات السريرية واستبيانات المرضى والصور السريرية وشفاء اللثة بعد العملية

المواد والطرق :في هذه الدراسة السريرية العشوائية ,تم إطالة تيجان 16 مريضاً(11 انثى و 5 ذكور) جراحياًباستخدام ليزر الدايود (940 نانو متر) في وضع الموجة المستمرة مع اعدادات الطاقة 1 واط. تم استخدام المقياس التناظري البصري في اليوم الاول والثالث والسابع والحادي والعشرين بعد الجراحة لتسجيل الالم والتورم والنزيف والتداخل الوظيفي وحساسية الاسنان والنجاح من الناحية الجمالية فضلا عن الرضى العام للمريض بناءا على رائي المريض والصور الفوتوغرافية.

النتائج: في هذه الدراسة , لاحظنا ان حجم الالم والنزيف والوذمة والتداخل الوظيفي وحساسية الاسنان قد انخفض بشكل تدريجي خلال اول زيارتين , اختفت المعلومات التي تم قياسها تماماً بعد اسبوع واحد في معظم الحالات , كم تحسن ايضاً رضا المريض والتحصيل الجمالي . تم استدعاء المرضى بعد ثلاثة اسابيع , وقد التئمت الجروح تماما ولم يشكو المرضى من اي نوع من الانزعاج .

الخلاصة: يتطلب اطالة التاج تصميمًا مثالياً لهوامش اللثة. يتضمن هذا التشكيل الدقيق للانسجة الرقيقة وهو امر صعب بااستخدام المشرط لكن يعطي الليزر تحكماً محسناً في نحت اللثة ويمكن استخدامه لاالة التاج التجميلي. هنالك العديد من المزايا لجراحة الليزر ,بما في ذلك الارقاء الممتاز مع القليل من النزيف او عدم وجود النزيف على الاطلاق ,كونه اقل تدخلاً وتعميقاً للجرح مما يسبب الماً ومعاناة اقل اثناء الجراحة وبعدها وتعزيز رضا المريض لان العملية قصيرة وغير مولمة في معظم الحالات .ايضاً في جراحة اللثة يكون هناك انقطاع وظيفي اقل ورضا افضل للمرضى نظراً لعدمالحاجة الى حزمة اللثة لتغطية موقع الحراحة .كذلك الشفاء اسرع واكثر جمالية عند استخدام الليزر للجراحة.