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**Institute of Laser for Postgraduate Studies**

# Gummy Smile Correction with 980 nm Diode Laser

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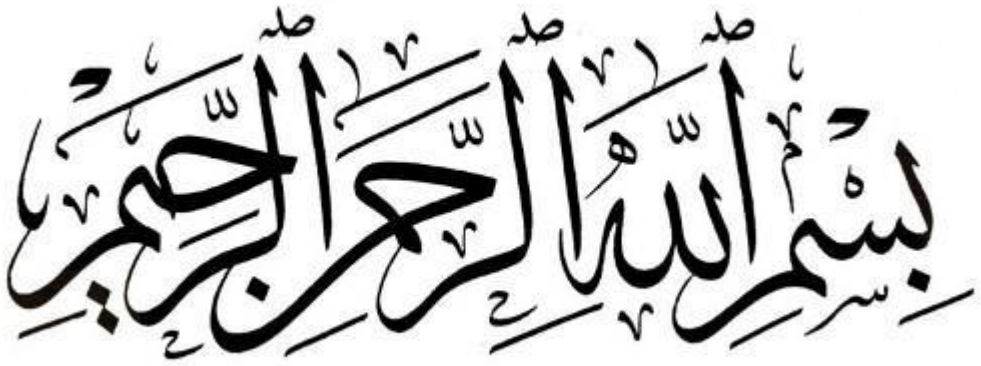


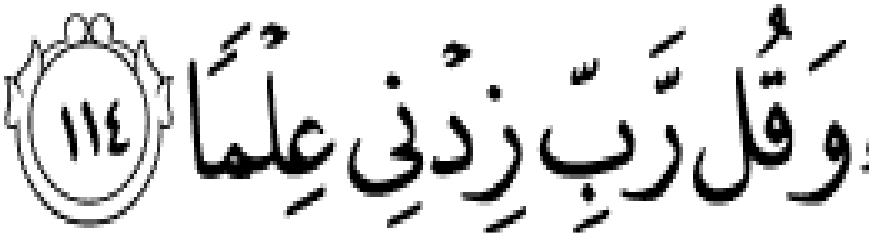


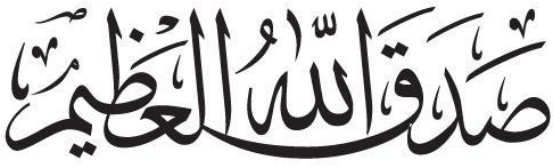


**سورة طه :الأيه١١٤**

# *Dedication*

*To my parents*

*The reason of what I become today, thanks for your great support and continuous care.*

*To my brothers*

*Iam really grateful to both of yours, you have been my inspiration and my soul mate.*

*To my husband*

*Thanks for being in my life.*

*To my little angle Al_Hassan & Wateen*

*My love and respect.*

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# Abstract

**Background:** 980 nm Diode lasers are becoming popular in periodontal surgery due to good absorption by tissue pigments such as melanin and hemoglobin with weak absorption by water and hydroxyapatite make it safe to use around dental hard tissues. A person's personality would not be complete without a smile. A winning smile is associated with intelligence and achievement, while a gummy smile is a passionately demanding esthetic worry for many patients. The most contentious aspect of treating a gummy smile is determining a correct diagnosis. If that's finished, the recovery strategy can be predicted becomes easier.

**Objective**: The purpose of this study is to evaluate the efficiency of diode laser 980 nm in performing lip reposition in comparison to conventional surgical technique depending on clinical observation and patient outcome.

**Materials and methods: (**40) patients whose age range between 18 to 38 years with mean age of 28 needed surgical treatment for gummy smile correction; the patients are randomly divided into (2 groups): study group that treated with diode laser 980 nm and control group who received scalpel lip repositioning. Patients were given a patient questionnaire to record pain and discomfort for first three days after surgery, one week, two weeks, three weeks and four weeks after surgery. pain and discomfort, bleeding, oedema, functional interference and overall satisfication were evaluated during follow up visits. Laser parameters setting were initiated with a diode laser, a wavelength of 980nm (QuickLase dentalase ,United Kingdom) applies 2.5W Power, continuous wave (CW) mode, 300µm tip & power density 83.33 W/cm$^2$

**Results:** A six male and thirty four female were involved in this study, age (18-38) years. There were significant variations in the pain and discomfort,

bleeding, oedema in laser group relative to the group that used scalpel. The study found: no significant in postoperative functional interference and overall satisfactions. The significance level was fixed at $P \leq 0.05$.

**Conclusion:** the diode laser is a good alternative to the conventional scalpel technique for performing lip repositioning and may provide additional benefits of clear surgical field with better gingival healing as well as reduced operation time with less amount of local anesthesia needed for laser surgery.

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# List of Abbreviations

| | |
|---|---|
| APE | **Altered passive eruption** |
| BTI | **Botulinum toxin injection** |
| CO2 | **Carbon dioxide** |
| CEJ | **cemento-enamel junction** |
| CW | **Continuous wave** |
| CLS | **Crown lengthening surgery** |
| C | **Degree Celsius (unit of temperature)** |
| Er,Cr:YSGG | **Erbium" chromium:Yattrium" Scandium" Gallium & Garnet** |
| EGD | **Excessive gingival show** |
| FDA | **Food and Drug Administration** |
| GE | **Gingival enlargement** |
| M | **Gingival margin** |
| GS | **gummy smile** |
| HUL | **Hyperactive upper lip** |
| InGaAs | **Indium-Gallium-arsenide** |
| IDG | **Interdental gingiva** |
| ISO | **International Organization for Standardization** |
| J | **Joule ( Energy unit)** |
| LSO | **Laser safety officer** |
| LLSAN | **Levator labii superiois alaeque nasi** |
| LLLT | **Low level laser therapy** |
| M | **Meter** |
| µm | **Micrometer** |
| mm | **Millimeter** |
| MGJ | **mucogingival junction** |
| Nm | **Nanometer** |
| Nd: YAG | **Neodymium doped Yttrium –Aluminum Garnet** |
| NOHD | **Nominal Ocular Hazard Distance** |
| No | **Number** |
| PD | **Periodontal treatment** |
| PDT | **Photodynamic therapy** |
| PPS | **pulses per second** |
| RP | **Reference point** |
| S | **Second (unit of time)** |
| SCC | **short clinical crowns** |
| UV | **Ultra violet** |

| | |
|---|---|
| Hz | **unit of frequency** |
| VME | **Vertical maxillary excess** |
| W | **Watt (unit of power)** |
| W/cm2<br>PSS | **Watt per centimeter square (unit of power density)**<br>**Patient satisfaction score** |
| Λ | **Wavelength symbol** |

# CHAPTER ONE

# INTRODUCTION AND BASIC CONCEPTS

# Introduction and Basic Concepts

## 1.1 Introduction

“Beauty is the sword of power; a smile is the sword of beauty.” Charles Reade, a British playwright and novelist, made this remark.

According to hulsey: Smiling is a facial expression that conveys happiness, cheer, satisfaction, and never ending pleasure. Individuals, regardless of culture, may use facial expressions to express feelings that are known across the world without using words. Lip position, teeth, and gingiva architecture are three basic elements of a pleasing cosmetic smile. **(Alammar et al., 2018)** .

The smile is important in speech and appearance because the mouth is the focal point of communication. Although dental practitioners focus their attention on the teeth, the location of the lips, the state of the oral tissues, and gingival outlines are all factors that influence the final appearance of a smile. Today, creating the perfect smile is a challenge, as treatment is needed. (**Dayakar et al., 2018).**

“gummy smile” (GS) Excessive gingival show (EGD), is a nonpathological disorder that causes esthetic disharmony When more over three to four mm of gingiva is visible while smiling. (**Esthetics, 1999**). A gummy smile, also known as: (high smile line` a horse smile` or gingival smile line ) is a disorder in which the maxillary gingival during smiling is shown excessively. **(Allen EP, 1988**).

For many patients, excessive gingival show is an esthetic problem.Vertical maxillary excess, dentoalveolar extrusion, or inadequate disclo sure of the anatomic crown, commonly known as altered passive eruption, are all

skeletal conditions that can produce this appearance. It's possible that a short up

per lip or a lot of lip translation is at cause.There might be a combination of factors at play**. (Carranza, 2018)**

A genuine smile is a multi-layered expression. When looking at the dilemma from the perspective of the face, the smile starts when the corners of the mouth stretch laterally. Unless you have a short upper lip, that is, lips appear to stay incontact at first. As the smile widens and moves closer When you laugh, Your lips are apart, your mouth angles are flexed upwards, and your superior teeth are visible. The mesial half of the upper 1st molars & the lower 2nd premolar may be visible when the angles of the mouth widen and the lips separate, while the front upper lip rises to meet the superior incisive collar.The upper lip levator muscles and the nasiolabial fold, whose fibers are integrated into the top lip by the fold, start the smile with muscle bundle contrac tions The upper lip is pulled up to the level of the anterior teeth by the medial muscle bundles, while the upper lip is pulled up to the level of the posterior teeth by the lateral muscle bundles. Because of the high cheek fat, After that, the lip runs into resistance at the fold. The fold becomes more noticeable. The levators, particularly the zygomatic major and superior levators, Increase the height of the lip, fold, and cheek. The periocular muscles flex at the end of a smile, causing the eyes to blink. Furthermore, everyone's nasolabial fold has anatomical and functional muscular variability, which can affect one's ability to display gum during a smile**. (Monaco et al., 2004), ( Fornaini, 2007).**

Between the left and right 2nd upper premolars, A gingival William's probe was used to assess gingival show, which was positioned parallel to the teeth's longitudinal axis. The gingival edge of the anterior maxillary teeth was measuredfrom the inferior border of the upper lip vermillion to the gingival edg e, to the closest millimeter of the gummy grin**. (Alammar et al., 2018)**

Traditional lip repositioning with scalpel tills is now the most popular technique, with the advantages of low cost and instrument reliability, but

hemostasis can be difficult to achieve.( **Fornaini et al., 2007)( Amaral et al., 2015**). Since the invention of the ruby laser (**Maiman, 1960)**, there has been a lot of interest in using lasers as an adjunctive technique in periodontal surgery because they are less invasive**. (Goharkhay et al., 1999) (Aoki et al., 2004) (Mavrogiannis et al., 2006) (LASER Safety Manual, 2007) ( Fornaini, 2007) ( Kravitz and Kusnoto, 2008),**

Periodontal surgery has used a variety of lasers, including the Nd: YAG laser, diode laser, CO2 laser, and Erbium laser family. According to reports, diode lasers have many benefits in soft tissue surgery, including reduced bleeding, discomfort, infection, and scar formation. Diode is a type of semiconductor. the diode laser was successful in reducing microbial populations, and it is safe to use near hard tissue since it only absorbs pigments in soft tissue. **(Robert AC, 2011).**

## 1.2 Facial Muscles (Muscles of Facial Expression; Mimetic Muscles).

The facial muscles are skeletal muscles found in the face's superficial fascia. They are not to be confused with the masticatory muscles (the muscle responsible of mastication such as masseter and temporalis, for example), which are located in the mouth. The smooth arrector pili muscles, which bind to hair follicles, are found in the face. Facial muscles are called integumentary muscles because they are located on the surface of the skin.The majority of them are caused by All of the skull's bones are linked to the skin or other facial muscles.The primary biological role of the facial muscles is to control (constrict) facial expression or (dilate) the orifices of the face (i.e., the orbits, nostrils, mouth, and ears).The facial muscles must be considered an accessory because of these behavior Vision, olfaction, respiration, feeding, speech, and hearing muscles are all involved. Facial expression is a by-product of fine regulation of the orifices in the face, and facial expressions are actually orifice displays (consider what you do when you smile, frown, grin, glare, and so on). Individual differences in shape, thickness, weight, and general degree of development exist in the facial muscles. As a result, their acts are highly variable and diverse, especially in their more subtle applications. The facial nerve supplies all of the facial muscles, which arise from the 2nd pharyngeal

arch The facial orifices are protected by the eyelids, nostrils, tongue, and auricles These structures are surrounded by facial muscles. **(García Reyes, 2013) (Malkinson et al., 2013).**

In humans, the auricular muscles that control the external ear are basically a set of vestigial muscles. The main sphincter muscle of the lips, the orbicularis oris, has a complex structure. Some of the fibers come from the maxilla above and the mandible below, and they emerge near the midline.Other fibers emerge from the skin's deep layers and travel in tilted manner to the mucous membrane that lines the lip`s inner surface.The buccinator muscle provides many of the fibers.The dilator muscles are a group of small muscles that emanation from the lips. They work by separating the lips, which is normally followed by the opening of the jaws. Muscles are derived from bones. The fascia surrounding the oral aperture converges and is injected into the lips material. The muscles are called as follows when traced from the side of the nose to the mouth's angle, then below the oral opening: **(García Reyes, 2013)**

1. Levator labii superioris alaeque nasi (this also dilates the nostril)
2. Levator labii superioris
3. Zygomaticus minor (an inconstant muscle that often is part of the
4. orbicularis oculi)
5. Zygomaticus major
6. Risorius
7. Levator anguli oris (deep to the zygomatic muscles)
8. Buccinator
9. Depressor anguli oris
10. Mentalis**.**
11. Depressor labii inferioris

AS Shown in figure below

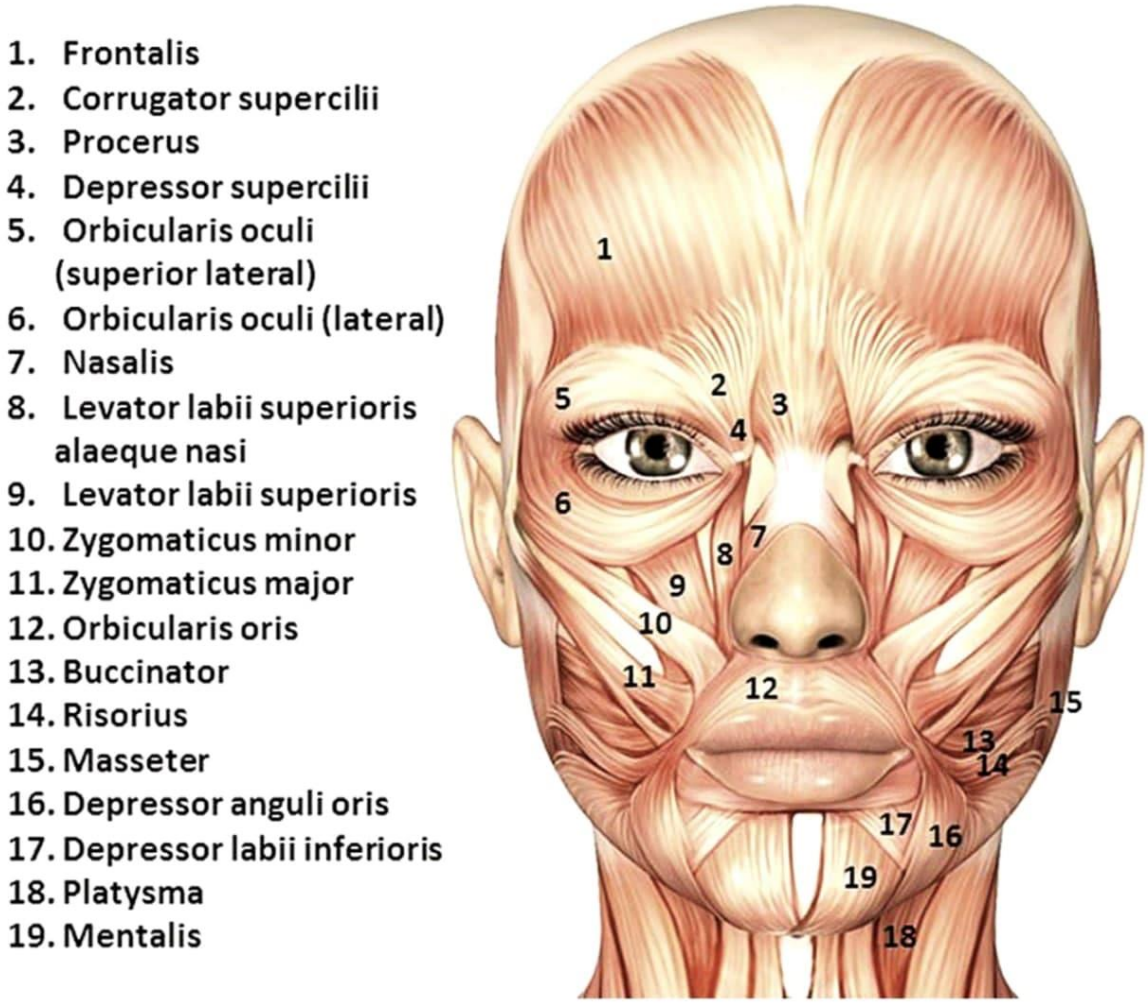



Figure (1-1) the facial muscles (**Nestor et al., 2017)**

## 1.3 Oral Cavity

From the lips to the pharynx, the oral cavity is located, The oropharyngeal isthmus, which is the entrance into the pharynx, is formed by the paired palatoglossal folds. The oral cavity has two parts: lip and vestibuler **(García Reyes, 2013)**

### 1.3.1 Lips

Lips are two fleshy folds that cover the mouth's opening. They are skin-covered on the surface and mucous membrane-lined on the inside. The

orbicularis oris muscle and the muscles that extend from the lips into the face make up the content of the lips. The blood vessels and nerves of the labial region , as well as connective tissue and a variety of other structures, are all included. salivary glands are tiny glands that produce saliva. The philtrum is a shallow vertical groove on the upper lip's superficial surface that runs along the midline. The labial frenulae are mucous membrane folds that attach the lip`s inner surface to the gums. **(Malkinson et al.,2013), (Dyme &piere, 2020).**

### 1.3.2 Vestibule

The vestibule is a slit-like gap between the exterior lips and cheeks and the interior gums and teeth. The oral fissure between the lips is where it interacts with the outside world **(Bohlen, 2010).**

When the jaws are closed, it interacts with the oral cavity just below the third m olar tooth on either side. Below and above, The mucous membrane from the lips and cheeks reflects onto the gums, limiting the vestibule.The lateral wall of the vestibule is formed by the buccinator muscle,w hich is made up of the buccinator muscle and coated with mucous membrane. Elastic fibers in the submucosa tether the mucous membrane to the buccinator muscle, preventing bitten between the teeth while the jaws are closed, resulting in redundant folds of mucous membrane. **(Bohlen, 2010), (Dyme & piere, 2020)**

The mucous membrane of the gingiva, or gums, is firmly connected to the alveolar periosteum. The buccinator muscle and the muscles of the lips hold the vestibule walls in contact with one another. On a small papilla opposite the upper second molar tooth, the duct of the parotid salivary gland exits into the vestibule. Excessive gingival show improved people's perceptions of how beautiful their smile is, as well as how polite, trustworthy, intelligent, and self-assured they are. (**Malkinson et al., 2013**).

In today's culture, a friendly smile is regarded as a sign of elegance and well-being, and periodontology deals extensively with soft tissue procedures.

This gingival exposure is variable, and it was more prevalent in females (14%), while it was recorded in 7% of males. (**Ersheidat et al., 2019)**

One of the foundations of the clinical care we provide as dentists is esthetics. With both shape and purpose in mind; An esthetic smile has the following characteristics: The smile line matches the convexity of the lower lip, the central incisors are symmetrical, the gingival margins of the central incisors are symmetrical, and the dental midline is linear. From the central incisors to the canines, incisal embrasures deepen progressively, teeth are straight or mesially inclined, and the width-to-length ratio of the central incisors is 75-80%. Other factors that affect the appearance of a smile include incisor show and gingival showing. **(Malkinson et al., 2013)**

The gingival margin of the central incisors and the lower border of the upper lip, a standard gingival showing during a regular smile is 1-2 mm." On the other hand, a distance of 4 mm or more between the gingiva and the lip is considered unattractive. Excessive gingival display is a common cause of gum disease "a gummy smile .When the patient is completely smiled, the lip line is the maxillary incisors' exposure at rest and, to a lesser extent, when laughing, decreases as people get older. At least one of the following anatomic entities has a discrepancy: the maxilla, lip, gingiva, or teeth, and tongue are the most common. To achieve an attractive smile, all of these anatomical markers must be in harmony with one another. The clinician must accurately identify and characterize the cause while diagnosing and treating individuals with a gummy smile. **(Pavone et al., 2016), (Dym & Pierre, 2020)**.

Since the maxillary arch is the most visible of the arches in a smile in most patients, the appearance of a gummy smile is attributed to factors primarily linked to it. As a result, smile esthetics research has centered on the

maxillary arch. The mandibular arch has not been examined in the same way. (**Bohlen, 2010).**

## 1.4 Classification of the (smile line) upper lip, interdental and marginal gingiva.

Aesthetics has now become a need for an ever-increasing population. Most of the time, aesthetic dentistry gives great solutions to improve people's ap pearances, which in turn enhances self-confidence (**Tejal. . et al, 2013**).

It's not just about dealing with misaligned or unsightly teeth caused by for m, decay, or color, for example. Aesthetic dentistry is concerned with the smile' s "elements" or components which are teeth, gums and lips. **(Pavone et al., 2016)**

When dealing with a patient's aesthetic request, we sometimes need to take a multidisciplinary approach.Excessive gingival show "Gummy smile," which may be a major source of patient concern, is one of the issues that has a "huge influence" on how individuals seem.Gingival and skeletal abnormalities may necessitate more extensive esthetic rehabilitation in some individuals. For these difficult patients, a multidisciplinary approach can help to improve the balance and harmony of all three aspects of their smile. **(Dary, 2017)**

**Classification of smile line**

In our everyday practice, we see a lot of patients who have a gummy smile as their main complaint. The clinician must also evaluate the patient's smile and consider the relationship between the patient's dentition, gingiva, and lips when smiling as in table below. (**Chopra et al., 2020**)

Table (1-1) classification of smile line according to amount of gingival display **(Dary, 2017)**

| Class | Type: Description | Evaluation |
|---|---|---|
| Score 0 | Low smile line | Interdental gingiva (IDG): <25% visible<br>Gingival margin (M): Not visible, teeth masked |
| Score 1 | Average/ ideal smile line | IDG: 25-75% Visible<br>M: Visible on individual teeth |
| Score 2 | High smile line | IDG: >75% Visible<br>M: <3mm Visible (overall) |
| Score 3 | Very high smile line | IDG: Completely visible<br>M: >3mm wide maxillary band of gingiva visible beyond the mucogingival line "gummy smile" |

## 1.5 Potential causes of excessive gingival show

There are multiple reasons why a person may show a gummy smile as a feature of their mouth. Knowing the reason why more gum shows when smiling help professionals to find the most appropriate aesthetic treatment.

1. Lips are short in span. Females have an average lip length of 21.18 mm and males have an average lip length of 24.14 mm measured from the base of the nose to the inferior edge of the lip. (**Peck et al.,1992**).

2. Lip activity that is hypermobile or hyperactive lip, The average upper lip movement from rest to full smile was found to be about 6.22 mm. Patients with HUL have more effective lip-elevation musculature and

more GD (one millimeter) when smiling than patients without GD. (**Peck S et al.,1992).** Lip movement of 7-8 mm is seen in a typical esthetic smile, according to UCLA Center for Esthetic Dentistry studies. (**Sabri, 2005**). HUL is regarded the key etiologic element in EGD when the upper lip length was within a normal range & a bottom third of the face was proportional to the remaining thirds. When patients smile, HUL is the amount of the lip movement occurs. The dentogingival exposure during the maximal smile was subtracted from the incisal exposure at rest to arrive at this result. **(Robbins J.W.,1999*),* (Pavone et al.,2016), (Bynum 2016)**

**3.** A short clinical crown is any tooth that preserves less than two millimeter s of sound, opposing parallel walls following occlusal and axial reduction & the Diseases that are a common cause of short clinical crowns (SCC) include: **(Ashu Sharma et al.,2012)**

A. A traumatic event (fractured teeth, attrition). **(Ashu Sharma et al.,2012)**

B. Iatrogenic dentistry is a term that refers to dentistry that is caused by (excess tooth reduction, large endodontic access openings). **(Ashu Sharma et al.,2012)**

C. Disruption in the eruptive process (insufficient passive eruption, mesially tipped teeth). **(Ashu Sharma et al.,2012)**

D. Exostosis and tooth form genetic variation**. (Ashu Sharma et al.,2012)**

4. Extrusion of the dentoalveolar membrane. Dentoalveolar extrusion is caused by the over eruption of the maxillary anterior teeth, which is common in Class 2 malocclusions. can also be associated with incisal wear and deep bites. (**Silberberg N et al. , 2009), (Pavone et al., 2016**).

5. Altered passive eruption.( APE is “Where the gingival margin fails to recede to a level apical to the cervical convexity of the tooth crown

during tooth eruption," based on the current definition.(**Dolt& Robbins, 1997).**

6. Vertical maxillary excess. Patients with VME (also known as the long face syndrome) have a lower facial height that is excessive. Excessive vertical growth of the maxilla, a high mandibular plane angle, and average upper lip length with excessive show of the anterior maxillary teeth are all correlated with this disorder. 2-3 mm GD was discovered to be linked to VME. (**Schendel SA et al.,1976**), (**Pavone et al., 2016), (Bynum, 2016).**

7. Gingival hyperplasia. Gingival enlargement (GE) is a common symptom of periodontitis. Inflammatory enlargement, enlargement associated with systemic disorders or conditions, neoplastic enlargement, and false enlargement are some of the etiological causes and conditions linked to GE . (**Mohamed& Marssafy, 2020**).

## 1.6 Diagnosis of Excessive Gingival Show

For a patient complains of a gummy smile, there are a few steps that must be followed in order to obtain the right diagnosis, In addition, a well-defined diagnostic approach should be utilized to accurately characterize the etiological, anatomic, and pathological reasons of a gummy smile. (**Pavone et al., 2016)**

Excessive Gingival Display (EGD) resulting from skeletal deformities, such as increased maxillary arch vertical height, typically requires orthognathic surgery. The majority of individuals with vertical maxillary excess (VME) is treated with orthognathic surgery alone. A multidisciplinary method with either orthognathic surgery, orthodontic therapy, or periodontal treatment was required in some cases of (vertical maxillary excess) VME. This operation requires a

hospital stay & a little days for recuperation. Significant swelling, edema, bruising, and pain can occur after surgery, and restorative dentistry may be required. **(Ozturan et al., 2014)**.

Furthermore, other factors were found to be significantly associated with GD during smiling such as. Altered passive eruption, (Altered passive eruption refers to an aberration in the eruption pattern of teeth that results in excessive gingival display).(**Bohlen, 2010**)

Skeletal class II malocclusion; Dentoalveolar extrusion results from over eruption of maxillary anterior teeth that is usually seen with Class II malocclusions. It can also be associated with incisal wear and deep bites. (Treatment of this condition includes orthodontic instrusion; possible

periodontal surgery or segmental osteotomy; and restorative treatment when abrasion is present). labially inclined upper incisors and lip; retruded mandible; greater overjet; greater overbite; and greater interlabial gap at rest. **(Daniela et al., 2018**). Crown lengthening surgery (CLS), which can be accomplished by gingivectomy or apically placed flap with/without ostectomy depending on Gingival width and alveolar bone crest location relative to cemento-enamel junction, can be used to treat EGD (CEJ). When hyperactive upper lip is the cause of EGD, non-surgical (botulinum toxin injections) or surgical treatment options are available. The diagnosis of a gummy smile should be established as early as possible. a thorough examination of the etiopathogenetic causes and the severity of the change, with regard to particular criteria. Given the severity and complexity of the gum exposures, the possibility of an orthognatodontic
, orthopedic, and/or surgical therapeutic resolution must be included in an appro priate treatment plan. **(Monaco et al., 2004) .(Gibson & Tatakis, 2017)**

## 1.7 Treatment of gummy smile divided into two option:

**1.7. 1 Non- surgical treatment option:** used to describe a medical treatment that does not involve cutting open the body.

**1.7.1.1 Botox injection:**

Onabotulinum toxin has a number of substitutes. For aesthetic purposes, a set of applications has been defined. On abotulinum toxin is used to treat excessive gingival showing. It is recommended that 2 to 7 U per side be used in the levator labii superioris & levator labii superioris alaeque nasi muscles, as well as 3 to 5 U in the depressor septi nasi, levator labii superioris, zygomaicus, or orbicularis oris. Before and two weeks after the operation, photographs and measurements were taken. Onabotulinum toxin is used to treat excessive gingival show. A is an effective and safe process that should be followed with caution to obtain the greatest results as shown in figure below. (**Sucupira & Abramovitz, 2012)** .


**Figure (1-2)** Photographs of the pretreatment (A) and posttreatment (B). a symmetrical smile on the face of a 30-year-old black lady, 2.32 U per side was used in the treatment.**(Sucupira & Abramovitz, 2012)**

By blocking acetylcholine release at the neuromuscular junction, it induces muscle paralysis. As a result, acetylcholine exocytosis is blocked, causing a neuromuscular block. The use of therapeutic dosages allows for partial muscular paralysis. This technique's drawback is that it is not permanent; it requires repeated treatment every few months. **(Dary, 2017)**

### 1.7.1.2 correcting gummy smile using hyaluronic acid injection

Excessive gingival show on smiling of any cause met the study's inclusion criteria, including gingival exhibition of at least 3 mm on unconstrained, non-posed, "full-blown" smiling. Before & after treatment, as well as 2 weeks and 6 months afterwards, photographs and measurements were taken. Hyaluronic acid was infiltrated into the paranasal region, around 3 mm lateral to the alar cartilage wing, at the most cranial part of the nasolabial fold. Without using local anesthesia, a 0.22 (0.2 _0.3) cc bolus of hyaluronic acid is infiltrated into etherside,following a vector perpendicular to the cutaneous plane once the bony surface was touched, to lightly compress the lateral fibers of the LLSAN without entering it, using a 30G needle, 13 mm long. Subcutaneous injection was used, with meticulous aspiration beforehand to avoid intravascular injection. The infiltration is made at a steady pressure to allow for gradual storage of the product at a chosen location without causing vessel compression. Reference points (RP) & linear measurements are established as in figure below. **(Diaspro et al., 2018).**

**Figure (1_3)**: correcting gummy smile using Hyaluronic acid injection. **(Diaspro et al., 2018)**

### 1.7.2 Surgical treatment options.

The importance of this cannot be understated. the etiology must be known prior to any surgical procedure in order to direct the necessary treatment. Following the identification of the etiology, the clinician should develop care options for the patient` involving all complications, advantages, & alternatives. The dentist could pay attention to the ultimate purpose of patient & customize the treatment plan to the patient's unique requirements. Because not all patient desires orthognathic surgery to cure their VME, the physician must provide other treatment choices that will assist the patient in achieving his or her overall objective while still adhering to appropriate standards.. For excessive gingival showing, various surgical methods are used**. (Gibson & Tatakis, 2017)**.

#### 1.7.2.1 Orthognathic surgery

Congenital and acquired dentofacial discrepancies are commonly treated with orthognathic surgery. Orthognathic procedures can be used in tumor resections and to treat individuals with obstructive sleep apnea syndrome in some cases. Better masticatory performance, less face discomfort, more stable outcomes in extreme discrepancies, and enhanced face attractiveness have all been noted as advantages. Many complications have been recorded, including vascular, technical, and temporomandibular joint difficulties; nerve damage; infections; bone necrosis; periodontal illnesses; ophthalmic and middle ear

alterations; Dysphagia, as well as psychological issues. Some of the problems might potentially be fatal. **(Panula et al., 2001)**

### 1.7.2.2 Gingivectomy

The width/length ratio of a maxillary central incisor should be clinically ideal. The crown should be between 0.78 and 0.85 in height. A central incisor with an 8.5 mm diameter should be between (10 -11 mm) long. ' The maxillary canine should be the same length as the central incisor or slightly shorter, and its gingival margin should match the central incisor's gingival edge. The marginal gingiva of the lateral incisor is normally around 1.0 mm coronal to the adjacent teeth's margins, but it is usually more in patients with a high lip line. It's nice to see the gingival edge of the lateral incisors match the gingival edge of the central incisors & canines. (**Gibson & Tatakis, 2017)**.

To achieve a smile with minimal gingival exposure, the entire anatomic crown must be exposed. Clinical crown width and length, anatomic crown length, and keratinized tissue height should all be measured prior to surgery. Soft tissue excision only or flap surgery with or without osseous surgery are both options for surgical crown lengthening. The factors that influence surgical procedure selection the need of the keratinized marginal tissue is at least 3.0 mm, and the possibility of osseous surgery. Soft tissue excision alone is the treatment of choice if osseous surgery is not needed and soft tissue excision for full anatomic crown exposure leaves at least 3.0 mm of keratinized marginal tissue. An apically placed flap would be needed if less than 3.0 mm of keratinized marginal tissue remained after the necessary excision as in figure below**. (Carranza, 2018)**


**Figure (1-4)** A, Pre-treatment image of the clinical crowns, which are short.
A diode laser was used to eliminate excess tissue in B.
Gingiva retraced C.
D, A view of the patient after surgery enhanced gingival appearance **(Carranza, 2018)**

### 1.7.2.3 Myotomy of the Levator Labii Superioris

The technique was performed under local anesthesia. In the columella, between the caudal septum & alar cartilages, a 5mm incision was made, identical to the transfixion incision performed on rhinoplasties & 2 mm lateral incisions were made at the inner aspect of the nostrils. Using a periosteal elevator, The gingival mucosa was completely detached from the maxilla in the subperiosteal plane by the columellar incision. The dissection region Below the pyriform aperture & between the two 1st molar teeth is the anterior maxilla **(Ozturan et al., 2014**).

The anterior maxilla is located below the pyriform opening & between the two 1st molar teeth. The nose (above), the oral commissures (laterally) & the lip mucosa all restrict the undermined region (below). The levator labii superioris muscles were also established by these lateral incisions. Their fibers are aligned

vertically and are situated immediately below and lateral the incision. A Mixter forceps is used to dissect them, and a no. 15 blade is used to amputate them. If required, the lateral incision may be lengthened to allow for better muscle exposure. A frenectomy is a procedure that lengthens the upper lip. Three 5-0 absorbable stitches are used to suture the frenum vertically after it has been sliced horizontally. The surgical site was stated to be tense by many of the patients. This was exacerbated by the suturing of the lip, and it is an unavoidable outcome. Erbium lasers with the wavelength of 2,780 nm are known as Er,Cr:YSGG lasers. Because water droplets absorb this wavelength of light intensely and can create flames, it's suitable for use on both hard and soft tissues. The Er,Cr:YSGG laser was cutting soft & hard tissues without raising the temperature, according to a previous study, resulting in faster post-surgery recovery. Furthermore, the operator has the ability to adjust the settings for various forms of treatment. The surgeon use a sapphire tip with 3 distinct settings to help healing & minimize discomfort, according on the surgical design and incisions as shown in figure below. (**Suh et al., 2020) (Ishida et al., 2010).**

Myotomy is the more invasive of the two surgical techniques, with permanent outcomes and a higher risk of postoperative morbidity, such as paresthesia. Lip repositioning, on the other hand, is a less invasive procedure. **(Ozturan et al., 2014**)

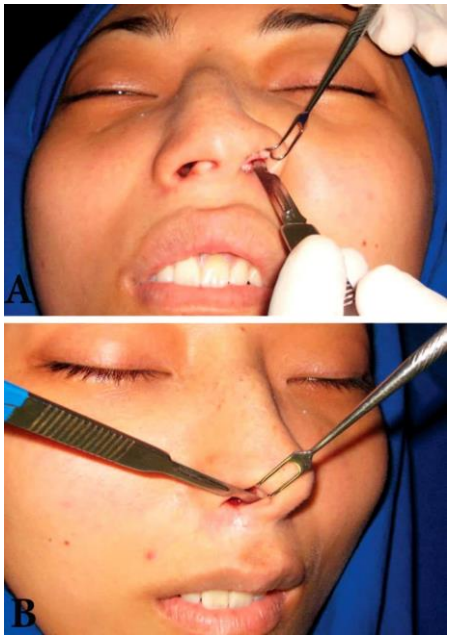



**Figure (1-5**) **(A)** The left inner lateral nostril was incised**.**
**(B)** An incision between the septal & alar cartilages has been created at the columella. **(Ishida et al., 2010).**

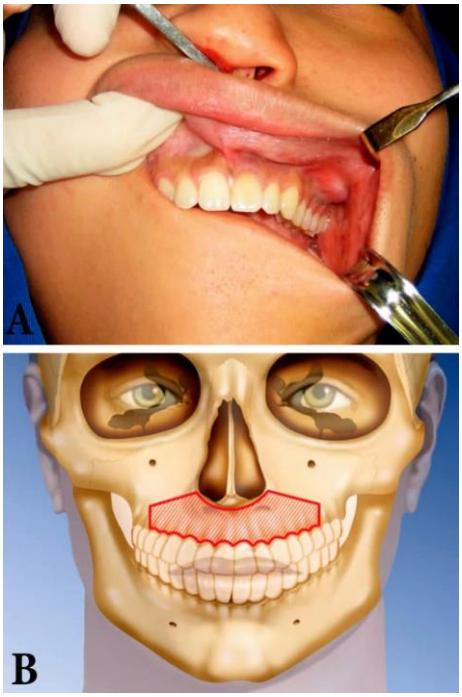



**Figure (1-6) (A)**The elevator was used to accomplish subperiosteal dissection into the columellar incision
**(B)**Anatomical diagram of the front maxilla. **(Ishida et al., 2010).**

### 1.7.2.4 Lip repositioning

Friedman coined the term mucogingival surgery to describe surgical procedures for correcting relationships between the gingiva and the oral mucous membrane with three particular problem areas in mind: attached gingiva, shallow vestibule, and frenum interacting with the marginal gingiva. The development in periodontal surgical methods has resulted in a decrease in periodontal disease. As a result, mucogingival surgery was called “periodontal plastic surgery” at the 1996 World Workshop of Clinical Periodontics. Miller coined the word “surgery” in 1993, and it has since been expanded to include **Periodontal-prosthetic problems are being addressed**

- lengthening of the crown
- Preservation of sockets
- augmentation of the ridge
- Surgical corrections for aesthetic reasons
- Reconstruction of papillae Coverage of the denuded root surface
- Around implants, esthetic surgical correction is needed
- Unrupted teeth are surgically exposed for orthodontic treatment.

## 1.8 Techniques of lip reposition

## 1.8.1 Conventional Surgical lip reposition by scalpel

Scalpels do not have adequate haemostasis, which is critical for highly perfused tissues including inflamed gingiva. The introduction of diode lasers that are highly absorbable by melanin and haemoglobin allows for soft tissue

manipulations that provide good results in periodontal surgery, treatment-related tissue changes, and oral lesions.(**Dary, 2017)**

## 1.8.2 Lip reposition by electrocautery

Because of it was ease of use, precision, & minimal tissue damage, the scalpel was widely recommended. Electrocautery was used in a blend mode (cutting and coagulation at the same time) to improve haemostasis through sealing blood vessels in the mucosal incision. The electrocautery cutting uses a continuous current to quickly heat the tissue to obove 100°C, vaporizing the intracellular matter. The current was intermittent in coagulation mode, so a higher voltage was needed to reach the needed effect. The more soft-tissue destruction was possible in higher voltage. This could lead to more scarring and contraction as the wound heals According to Louis and colleagues (**Liboon et al., 1997). (Massarweh et al., 2006**).

The tonicity, thickness, & reaction of the superfacial soft tissue to movement of the underlying dental osseous portion will also be affected by soft tissue scarring and contraction..(Parente Dr. et al., 2011)

## 1.8.3 Laser lip reposition

Instruments with mirrored surfaces or highly reflective surfaces were avoided since the laser beam might be reflected. It was taken care not to use the laser in the presence of explosive gases.**(Ozturan et al., 2014)**

## 1.8.3.1 by Erbium –doped yttrium, scandium, gallium and garnet (Er,Cr:YSGG) Laser: (2780 nm)

The YSGG laser system has been shown to selectively absorb by target tissue (water molecule), resulting in both a direct tissue incision (cold cut) and vaporization of water in a cell Histamine release was seen to be reduced in laser-

treated tissues. This vaporization causes thermal-mechanical tissue ablation which causes a rupture (thermal cut). Collagen disruption is reduced to less than 5um (roughly two cell widths) by thermal mechanical tissue ablation, leaving the extracellular collagen matrix largely unchanged. device, which explains why pain and inflammation are decreased or absent during and after surgery.There was almost absent scarring & just minor tissue shrinkage on crestal & sulcular cuts. The area to be extracted was determined after a local anesthetic infusion of 2 percent lidocaine and 1:80,000 epinephrine was given, taking into account the final lip position as well as the zone of keratinized gingival. **(Dary, 2017)**.

The superior boundary of this area ran parallel to the mucogingival junction on, whereas the inferior border ran 1 mm above the junction, separated by (10–15) millimeters. The surgical boundary in the right and left quadrants stretched mesiodistally between the mesial side of the 1st molar. The Er,Cr:YSGG laser (Waterlase, Biolase) with settings of (1 W, 0% ) air,( 0%) water & (30) pulses per second was used to delineate the surgical border (pps). The superficial mucosa is then extracted with a (4 W), ( 55 %) air, ( 65 %) water & (30) pulses per second setting . Although the minor salivary glands were spared direct damage, some glands were removed .**(Ozturan et al., 2014) (Dary, 2017)**

Set the Er,Cr:YSGG laser to( 4 W), (55 %) air, (65 %) water & 30 (pulses per second) using the Er,Cr:YSGG laser. A Sapphire G6 tip is used for every surgical procedures (Waterlase, Biolase). one interrupted suture is 1st used at the midline to certify accurate lip placement. The continuous locking sutures are placed after in a quadran twise manner, starting at the midline & terminating at the distal portion of the canine & 1st molars, & reversed then. Following suturing, the laser was utilized at (1.5) W, (0% )air, (0%) water, H mode, and (30) pulses per second with low-energy settings. The postsurgical recommendations included using an ice pack for three -four days, eating a soft diet for first week, & limiting oral activities for 14 days, such as brushing near

the surgery place, extreme laughter, & repetitive speech. The suture are removed two weeks following surgery as in figure below. **(Suh et al., 2020**)

**Figure (1-7).** Surgical operations of the Er,Cr:YSGG laser using to make surgical correction **(Suh et al., 2020)**

### 1.8.3.2 Diode laser

The diode laser separates and coagulates the blood vessels at the same time, allowing for rapid haemostasis and minimal bleeding. Healing is fast, and the risk of infection is minimized. Since the diode laser is only attracted to soft tissue, it does not damage the surrounding bone or enamel. As a result, using diode lasers can be beneficial due to improved control, lower pain and inflammation, and faster wound healing. In the management of gingival exposure, researchers contrasted traditional lip reposition surgery with laser excision, finding that laser excision results in a lower rate of recurrence. The goal of this study was to see if a diode laser could be used instead of non-

surgical periodontal treatment. which resulted in a faster and more significant improvement in gingival health. Utilizing lasers in soft tissue procedures, researchers compared the diode laser (810 nm) to traditional surgery, finding that patients treated with the diode laser needed less infiltration anaesthesia. There was less bleeding during and after surgery, faster postoperative haemostasis, no need for sutures, and better postoperative relaxation and healing **(Lione et al., 2020)**.

## 1.9 Postoperative instructions (Lip repositioning instructions)

- For several hours, apply cold packs to the upper lip.
- For the first week, stick to a soft diet.
- For the first two weeks following surgery, avoid smiling or chatting.
- For 14 days, no cleaning near the surgery site is permitted.
- To control the postoperative pain, use analgesics tab.
- Suture is remove at two weeks after surgery. (**Alammar et al., 2018).**

## 1.10 postoperative complications

Postoperative problems such as pressure, bruising, edema, mucocele development, and the possibility of recurrence should all be discussed with the patient. **(Deepthi et al., 2018**) The upper lip's tiny salivary glands are severed may result in the development of a mucocele, which is a less common complication. A mucocele was encountered by one of the contributors, which resolved on its own. Parasthesia and intermittent paralysis are two other uncommon complications that have been documented in the literature. **(Rosenblatt & Simon, 2006)**

## 1.11 Relapse can be caused by a variety of factors

- During the incision, not adopting the “twice the gingival display” maneuver
- Keratinized attached gingiva cutting
- Using a small amount of keratinized attached gingiva for the procedure.
- Cases involving a significant amount of muscle pull**. (Sheth et al., 2013) (Foudah, 2019)**

## 1.12 Literature Review of Treatment of gummy smile by 980 nm Diode Laser;

The procedure is first mentioned in the literature of plastic surgery in 1973 by Rubinstein AM. Lip repositioning surgery aims to correct an unsightly gummy smile By restrictive the retraction of the elevator smile muscles (zygomaticus minor, levator anguli, orbicularis oris, and levator labii superioris), a tiny vestibule & restricted muscular pull are created, preventing gingival show while smiling. A partial thickness flap between the mucogingival junction and the upper lip musculature is created by extracting a partial-thickness flap between the mucogingival junction and the upper lip musculature formed by a strip of mucosa from the maxillary buccal vestibule. The mucogingival line is then sutured to the lip mucosa, narrowing the vestibule and limiting muscle pull. (**Rosenblatt & Simon, 2006).** In 1977, the same authors published a second paper on the surgery, in which they treated 92 individuals. They claimed that all of the patients they treated “improved satisfactorily” and that only “a few” cases of mucosal recurrence occurred as a result of “too conservative” mucosal excision. During the first week, patients experienced difficulties moving their lips, swelling, and considerable discomfort. (**Kostianovsky & Rubinstein, 1977).** In 1979, Kamer released a study on the same methodology, claiming it to be easy and effective .He suffered various difficulties after the surgery, including temporary partial paralysis, edema, and a

visible suture line for 6-8 months (**Kamer, 1979).** The similar method was reported by Litton and Fournier in 1979, with a few differences: a coronal incision line 3-4 mm above the anterior teeth and no upper wound flap. They advocate making the coronal incision closer to the teeth and disconnecting the lip muscles in individuals with excessively small lips when a considerable degree of repair is necessary. (**Litton &Fournier, 1979**). Rosenblatt and Simon did not incorporate the LRS into the dental literature until 2006. (**Simon & Rosenblatt, 2006**). Following then, other papers have appeared that use the same method as Rosenblatt and Simon. Some changes have been made, such as the labial frenum being spared.; ( **Mantovani et al., 2016)**. including myotomy of the labii superioris and depressor spti;( **Abdullahet al., 2014**) and using laser-assisted LRS.( **Ozturan et al., 2014**). **Silva et al. (2013**) 6-months PO, there was a considerable rise in top lip length and upper lip vermilion length. **Roy et al. (2016**) Similar outcomes were discovered, as well as a considerable reduction in the interior lip length as determined clinically. After therapy, several LRS case reports reported a larger upper lip look. ( **Jacobs & Jacobs, 2013), ( Mahn, 2016). Roy et al. (2016**) 6 months post-op, 43 percent of their patients were “extremely satisfied” with the size/fullness of their lips, while 36 percent were “very satisfied.” Despite the fact that the majority of papers claimed positive outcomes, there is little information in the literature about measurable patient outcomes. Abdulla et al. (2014) reported that 8 out of 12 patients were satisfied 12 months postoperatively. (**Abdullah et al., 2014**). **Silva et al. (2013)** 2.5 years Post Operative (OP), found that 46% of Patients were “extremely pleased” with their smiles, with 96 percent stating that the amount of gum visible was “just right”. (**Ozturan et al., 2014).** one year after treatment, 100% of their treated patients were happy with their smile, and 100% believed the quantity of gum visible was "about right." Roy et al. (2016) found increased quality of life, increased well-being, increased pleasure with esthetics, and less social appearance anxiety using psychological measures and

questionnaires post operative (PO) for 6 months. Rare complication of mucocele formation was reported in only one case report. The entire length of the top teeth is exposed with about (one _three mm) from gingiva exposed, is a feature of a "perfect smile" .Previously, typical surgical procedures were performed under local anesthetic using a scalpel. ( **Simon et al., 2007**)

Maiman was the first to introduce the laser in 1960. (**Maiman, 1960**). who made a laser out of ruby ((Carbon Dioxide Laser) CO2) & (Neodymium_Doped Yttrium Aluminium Garnet (Nd: YAG)) lasers are produced after some time. In the medical profession, laser photocoagulation of the retina was first utilized in 1960. (**Mahajan, 2011**). In 1964, Goldman was the first dentist to employ lasers in dentistry. **(Mahajan, 2011**). Myers published the first article on the use of lasers in periodontal surgery in 1989. (**Mahajan , 2011**). However, research at the time revealed that laser devices used for soft tissue cut & ablation are not acceptable for dental hard tissues, the Food & Drug Administration (FDA) eventually restricted CO2, Nd: YAG, & diode lasers to soft tissues exclusively. (**Mahajan, 2011**). Different sorts of lasers are now available to use by dentist: (CO2, Nd: YAG, Holmium Yttrium Aluminium Garnet (Ho: YAG), Er,Cr: YSGG, Neodymium doped Yttrium Aluminum Perovskite (Nd: YAP), Gallium Arsenide (GaAs) (diode), & Argon). (**Bains et al., 2010**).

Diode and neodymium: Despite their differences in wavelengths & output, diode & neodymium: In a similar way, In esthetic dentistry, YAG (Nd:YAG) lasers were used (Because both of them have strong absorption in soft tissue melanine & hemoglobin). When utilized in noncontact mode, both lasers penetrate deeply into soft tissue. The laser tip becomes carbonized when the end of the quartz fiber used to transport laser energy was first "activated" or "started" by turning on the laser & running the tip over a dark substance, such as blotting paper. The carbonized tip absorbs the laser beam's energy, causing the molecules in the tip to vibrate. Heat energy is converted from vibrations. Visible

light comes in the form of red and then orange as the tip warms up. When the tip reaches 900°C to 1200°C, this may be observed. The (hot tip) was a technique for removing tissue without causing bleeding or severe collateral tissue damage. In a contact mode, diode & Nd:YAG lasers were used to remodel gingival tissue. Both lasers have no effect on dental enamel, they should be used in direct connection with the teeth for the greatest effects. Beautifying gingivoplasty can be done at the similar visit as veneer preparation & impression to the new free gingival margin because these lasers have been revealed to produce minimal postoperative gingival depression. (**Magid & Strauss, 2007**)

## 1.13 Laser Basics

Laser is an acronym of Light Amplification by Stimulated Emission of Radiation. **(Baxter& Waylonis, 1995), ( Dunn et al., 2005).** In 1960, Theodor Maiman in California constructed the first laser by using ruby crystal. **( Kirk, 2008).** In 1962, gallium-arsenide (GaAs) semiconductor cooled laser developed by Hall and colleagues**. (Hall et al., 1962**). In 1964, the neodymium-doped yttrium-aluminum-garnet (Nd:YAG) laser was developed by Geusic, Marcos and van Uitert at Bell Labs**.( Geusic et al., 1964).** In 1964 the argon ion laser was developed by Bridges of Hughes Research Laboratories**. (Bridges, 1964)**. In 1964, developed the carbon dioxide (CO2) by patel at Bell Labs**. ( Patel, 1964**). While the dye laser developed in 1960 by sorokin & lankard. **(Sorokin &, Lankard, 1966), ( Sorokin & Lankard, 1967**). Zharikov et al. introduced Er: YAG laser in 1974 **.(Zharikov et al., 1975**). For general dentistry the 1st laser developed was dLase 300, Nd:YAG laser which was developed by Myers and Myers in 1990. **(Myers, 2000)**

## 1.14 Laser System Components

### 1.14.1 Active Medium

The active medium, which is made up of chemical components, molecules, or atoms was the heart of the optical cavity. Generally, lasers are called for the active medium component, which might be a gas (CO2), a crystal (Nd: YAG), a liquid (dye lasers), or a solid-state semiconductor (diode lasers). (**Coluzzi, 2008**)

### 1.14.2 Pumping Source

An excitation source surrounds the active medium. This pumping source produces steam, which is consumed by the active medium's atoms or molecules, allowing them to reach an excited state, resulting in the population inversion. Optical sources such as flash lamps or other types of lasers can be used to transmit energy to the active medium, an electrical pump and chemical pumping can be used **. (Fontana et al., 2004)**

### 1.14.3 Optical Resonator (Feedback Mechanism)

The optical resonator, as shown in Figure, consists of two mirrors, one at each end of the optical cavity, that are parallel to each other to complete the laser Cavity (Fig1-8). Instead of mirrors, two polished surfaces are used at either end of a semiconductor laser. ( **Fontana et al., 2004**).

The laser beam is formed as a laser exits the active medium and travels straight to the mirrors, where it can be mirrored back and forth across the active medium to collimate and intensify the forming beam. Each of the mirrors has a coating that is less than 100% reflective at the laser wavelength, allowing light to escape from the optical cavity known as the output coupler. (**Stratigos et al., 1998)**.

Focusing lenses, cooling system and other controlling mechanisms complete the laser cavity. ( **Fontana et al., 2004**)

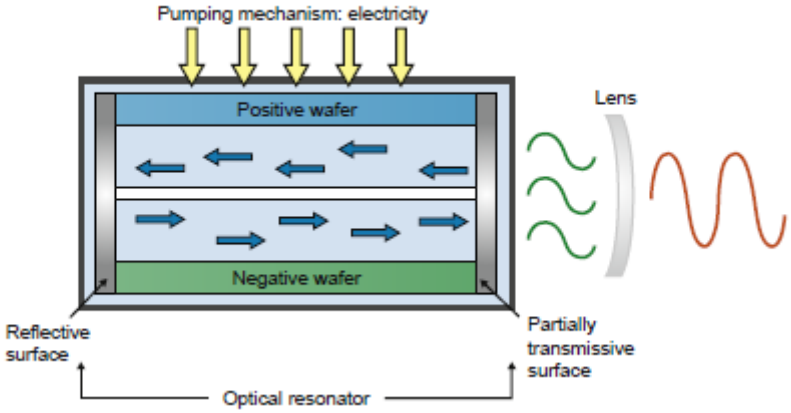



**Figure (1-8):** Basic component of Diode laser cavity. ( **Convissar, 2015**)

## 1.15 Properties of Laser Light

The laser light has distinct properties that set out from other light sources. as shown in Fig (1-9); these special features represent the basis of its therapeutic use these properties are. (**Stratigos et al.,1998).**

1. Coherence: All waves have the same frequency and amplitude, which is known as coherence (the difference in face between waves are fixed). Temporal coherence refers to that different portion of laser frequency bandwidth close in phase, while spatial coherence referred to closeness in phase of various spatial points of laser beam after propagation a certain distance. ( **Silfvast ,2003**)

2. Directionality: Collimation refers to the propagation of all light rays or waves in the same direction and parallel to one another. This property enables lasers to travel across large distances. (**Fontana et al., 2004), ( Silfvast, 2003**)

3. Monochromaticity: Monochromaticity describes how narrow the laser beam bandwidth was, or to how the laser beam clear in color. (**Guenther et al., 2003**).

4. Laser density: include power density (power per unit of area) & energy density (energy per unit area).

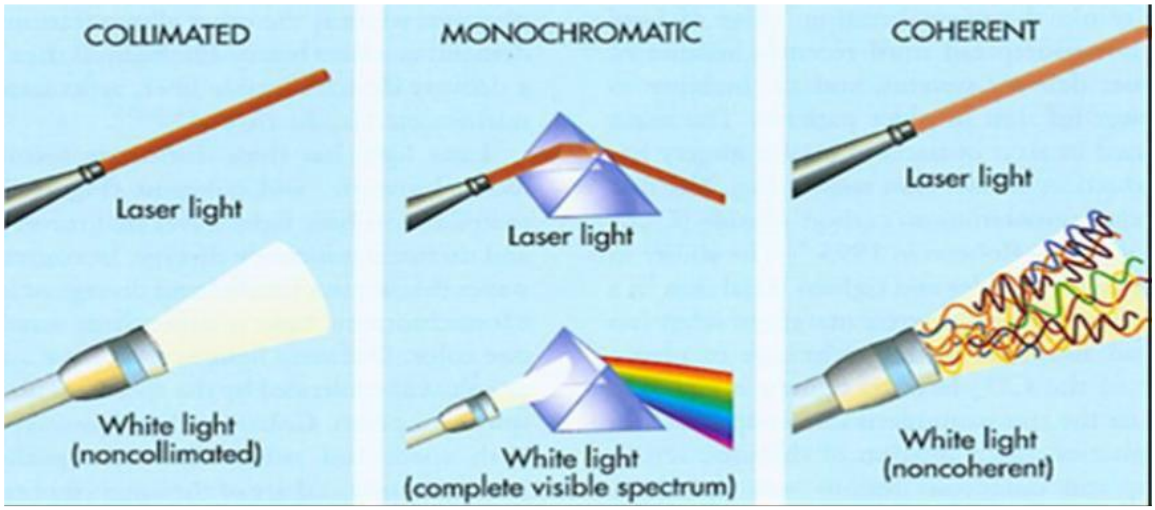



Figure (1-9): **Laser light properties** .(Guenther et al., 2003)

## 1.16 Laser Operation Modes

As a mode of action, laser devices can generate light energy in one of two ways: (1) continuous wave or (2) pulse. There are two types of pulse lasers: gated and free-running.

The following are distinct emission modes: (**Niemz, 2004)**, (**Robert**, **2011**)

Continuous-wave (CW) mode: With no power variations over time, the beam emits at a constant power frequency.

The pulsed laser: energy is chopped on a regular basis, much like a blinking light, in a gated-pulse laser. The closure and opening of a electrical chips or mechanical shutter in front of the continuous wave emission's beam direction achieves this mode.This gated-pulse function can be as brief as

microseconds or milliseconds in most surgical instruments that run in continuous wave (long pulses). (**Niemz, 2004)**, (**Robert**, **2011**)

Free-running pulsed mode: True-pulsed mode is another name for it. In free-running pulsed systems, the active medium is pumped by a rapidly light. Each pulse generates hundreds or thousands of watts of peak power. The power that the tissue exposed was limited due to the short pulse length. A free running pulsed system cannot employ a continuous-wave or gated pulse. The pulsed laser divided into two types depending on the pulse duration:

- Q-Switching pulse laser: It's a laser operation mode in which energy is retained in the active medium during pumping and then released in a single, brief burst. This is achieved by altering the laser cavity's input. The HR mirror is restored to optimal alignment and function after a significant volume of energy has been deposited in the active medium, and the majority of the stored energy returns in a single, fast pulse as short as nanoseconds. **Niemz, 2004)**, (**Robert**, **2011**).

- Mode locking pulse laser: It's made by trapping the cavity's longitudinal optical modes together. This is accomplished by locking the relative phase of all optical modes such that they all have the same phase at some stage .A positive interference with all of the laser modes occurs at this stage, resulting in a single pulse with a very short width and a very high peak intensity that passes between the mirrors of the laser. The laser output is an ordered sequence of pulses as a result of this traveling beam. Each pulse lasts anywhere from a few picoseconds to a few femtoseconds. **(Niemz, 2004)**, (**Robert**, **2011**)

## 1.17Laser Delivery System:

The delivery system must be convenient to the dental applications, and deliver the laser energy effectively with minimal amount of losses. (**Robert, 2011**)

- Articulated arms: used for UV, visible, and infrared lasers (with optical components at the joints).
- Hollow waveguides For middle and far infrared lasers, a lightweight tube with reflecting internal surfaces is used**.**
- Fiber optics is a type of laser that can produce visible and near-infrared light. Most dental lasers use this form so it can deliver laser energy to most areas of the oral cavity, including the complicated root canal system**.**

To make it easier to use, all transparent dental laser devices have a targeting beam in addition to the irradiation. It's either a normal light or another visible

## 1.18 Laser Tissue Interaction

When laser light is applied to biological tissue, various interaction mechanisms can occur. The effect of the laser will range from no effect to full ablation, depending on optical tissue properties and laser parameters. The most critical aspects that determine the The coefficients of reflection, absorption, and scattering are the sum of reflected and emitted laser light through tissue. When laser light hit the tissue, four different effects could occur as shown in Fig(1-10) (**Miserendino et al., 1995**) (**Niemz, 2004)**.

- Reflection: The beam is guided away from the target tissue and has little impact on it. It can be harmful since the energy may be redirected

unintentionally to an unintended goal, such as the eyes, which is a big laser protection issue. (**Miserendino et al., 1995) (Niemz, 2004).**

- Absorption: When a light beam travels through a medium, the amplitude of the incident light beam is attenuated. **(Miserendino et al., 1995) (Niemz, 2004).**

- Scattering: It is the changing of light beam directions within the tissue. Two types of scattering are distinguished: elastic & inelastic scattering, depending on whether part of the incident photon energy was converted during the process of scattering. Rayleigh scattering is a special kind of elastic scattering. The particles in this scattering are smaller than the wavelength of the incoming light. Brillouin scattering, which was inelastic scattering, is another significant kind. It occurs when acoustic waves propagate through a material, creating inhomogeneity in the refractive index. Mie scattering is another type of scattering, the Mie scattering and Rayleigh scattering different in two important respects. First, Mie scattering shows a weaker dependence on wavelength ($\sim \lambda$-x with $0.4 \leq x \leq o.5$) compared to Rayleigh scattering$\sim (\lambda$-4). Second, Mie scattering occur in the forward direction while Rayleigh scattering is forward and backward scattered. (**Miserendino et al., 1995) (Niemz, 2004**)

- Transmission: It is the passing of the laser beam directly through the tissue, causing no damage to the target tissue It is extremely reliant on the wavelength of the laser light. **(Miserendino et al., 1995) (Niemz, 2004).**

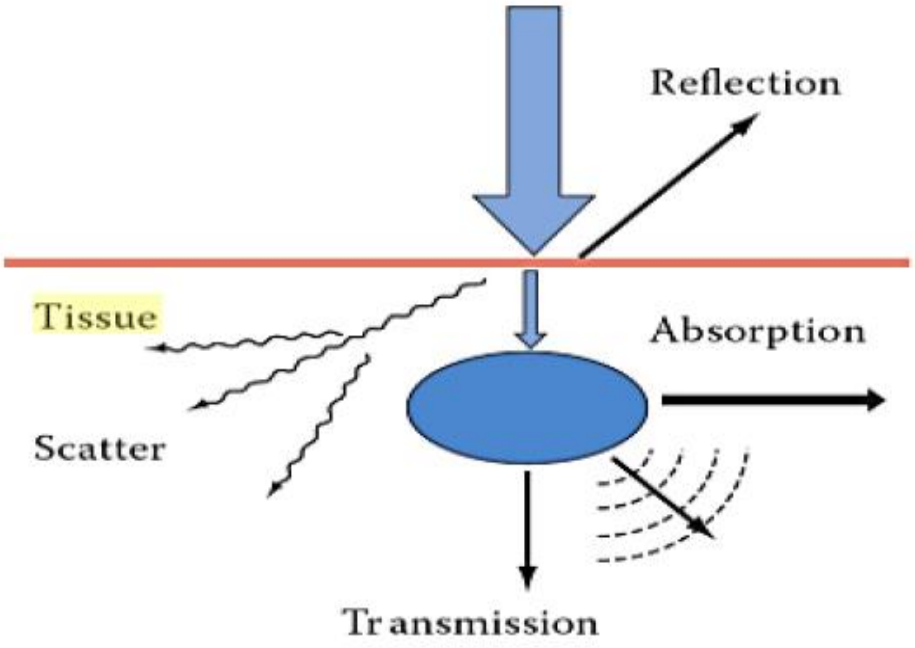



**Figure (1-10):** Laser tissue interaction**.** (**Chan & Ahmed, 2014)**

The amount of energy consumed by biological tissue is determined by tissue properties such as tissue chromophores or pigment (Fig 1-11), as well as the wavelength of the laser. Water molecules or macromolecules like proteins and other tissue pigments like melanin and hemoglobin may be the chromophores. Each laser has a unique wavelength that influences the target tissue's interconnected components such as vascularity, chemical composition, and water content. (**Fontana et al., 2004**).

In general, hemoglobin and other tissue pigments absorb lasers with wavelengths (in the visible and near IR regions, from 500-1000nm), while water and hydroxyapatite absorb lasers with longer wavelengths. (**Coluzzi, 2004)**.

The therapeutic range is between 600nm and 1200nm; the amount of absorbed energy is lowest in this spectral area, allowing treatment of deeper tissue. The electronic constitution of atoms and molecules, the thickness of the absorbing

substrate, & internal parameters as example the temperature or concentration of absorbing agents were all factors that influence absorption. (**Niemz, 2004)**

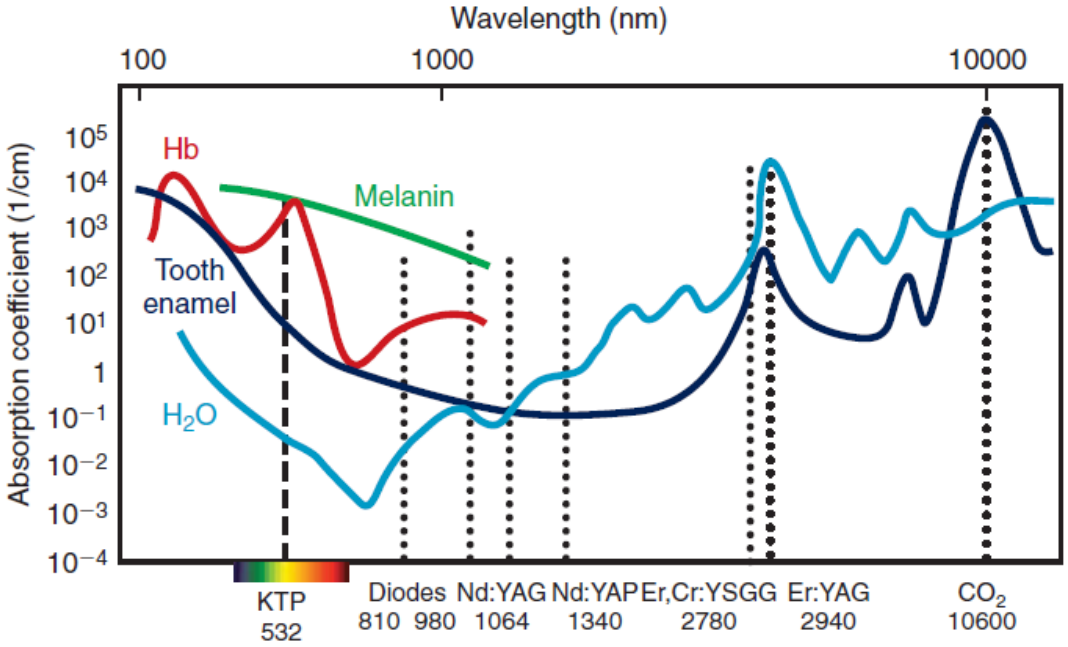



**Figure (1-11):** Absorption curves of several dental lasers **(Coluzzi, 2004).**

## 1.19 Laser Tissue Interaction Mechanisms

Laser tissue interaction pathways can be divided into two categories: those that are wavelength dependent (called "wavelength dependent") and those that are wavelength independent (called "wavelength independent"). . (**Niemz, 2004)**

### 1.19.1 Wavelength Dependent Mechanisms:

The absorbed energy was convert into thermal and/or mechanical energy that is use to perform the desired work.

### I. Photochemical Interaction Mechanism

Photochemical reactions occur as light causes chemical reactions in cellular molecules or photodecomposition of chromophores. They occur at low power densities and over long periods of time, varying from seconds to

continuous waves. Scattering dictated the light distribution within the tissue, which influenced the laser parameter selection. The effects of photochemical interaction can be observed in a number of ways. (**Niemz, 2004)**

**A- Photodynamic Therapy**

Exogenous chromophores, also used as photosensitizers, are used in photodynamic therapy to act as photoreceptors. Laser light of a certain wavelength is used to activate molecules or drugs; after these molecules absorb light energy, selective photochemical reactions occur. Which causes the release of extremely cytotoxic reactants, resulting in the irreversible oxidation of essential oils. Photoreceptors can retain energy in their excited states, and their deactivation results in poisonous substances such as oxygen free radicals, which can induce cellular death by destroying the DNA molecule. As a result, it is commonly used in the treatment of tumors**. (Niemz, 2004), ( Khosravi et al., 2008)**

**B. Biostimulation Therapy**

Photobiomodulation, or low-level laser treatment, is another name for biostimulation. Low irradiance or incredibly low laser power were used in this operation. It has many uses, including improved wound healing and pain management. It is linked to improving the biochemical processes in living cells. According to, the impact of low intensity light on cell growth demonstrates the The effects of helium-neon or diode lasers on local wound healing.(**Karu, 1987**).

Conditions are normally generated in the region of such accidents to avoid proliferation, such as low oxygen concentration or pH. Exposure to red or near-infrared light could thus act as a stimulant for cell proliferation. (**Niemz, 2004)**

## II. Photothermal Interaction

Most laser surgical applications rely on the laser-induced Photothermal effect, in which an increase in local temperature is a major parameter shift. (**Sobouti et al., 2014)**.

Laser radiation, whether continuous or pulsed, can cause thermal effects. There is no particular pathway in this form of laser tissue interaction; the spatial range and degree of tissue damage are largely determined by many factors, including magnitude, exposure time, and the location of deposited heat within the tissue. Laser factors such as wavelength, power density, exposure time, spot size, & pulse repetition intensity, also optical tissue properties & thermal tissue properties (heat capacity & thermal conductivity), all influence the total amount of absorbed laser light energy. The existence of such chromophores in biological tissue, such as free water molecules, proteins, pigments, and other macromolecules, is primarily responsible for absorption. (**Niemz, 2004**). The thermal effects of laser radiation and the biological effect are shown in Table (1-2).

**Table 1-2:** `Laser radiation's thermal effects ` **. (Niemz, 2004)**

| `Biological effect ` | `Temperature` |
|---|---|
| `Normal temperature` | **37 ` degrees Celsius.** |
| `Hyperthermia` | **45 ◦C `** |
| `Reduction in enzyme activity, cell immobility ` | **50 ◦C `** |
| ` coagulation, Denaturation of proteins & collagen ` | **60 ◦C `** |
| `Permeabilization of membranes ` | **80 ◦C `** |
| `Vaporization & thermal decomposition (ablation)` | **100◦C `** |
| `Carbonization` | **>100 ◦C `** |

## III. Photoablation Therapy

Srinivasan and Mayne-Banton were the first to discover photoablation in 1982, and they called it ablative photodecomposition. When the sample is irradiated with high intensity laser irradiation, it decomposes in a very smooth and precise manner, without the presence of thermal effects such as coagulation or vaporization (**Niemz, 2004)**

For laser pulse durations in the nanosecond range, the common threshold values for this sort of interaction are $10^7$-$10^8$ W/cm2. Due to the volume tension, the energy gain from the absorption UV photon exceeds the chemical bond energy of the tissue molecules, causing bond breakage and Photoablation. The energy gain from absorption of visible and infrared photons will not equal the chemical bond energy of tissue molecules, so ablation will occur after photons add up in energy, resulting in a global rise in temperature and noticeable thermal effects such as vaporization or melting. This form of ablation is known as Thermal decomposition. The main contact with dental hard tissue occurs at 100°C, as water is transferred to steam, which expands explosively and forces the tissue to be removed. (**Rechmannet al., 1998)** (**Niemz, 2004)**.

At this temperature tissue water vaporization occurs and this process is called ablation. (**McKenzie, 1990**)

### 1.19.2 Wavelength Independent Mechanism:

These processes are distinguished by optical breakdown and plasma forming and depend on high power density ($10^{11}$-$10^{16}$ W/cm2) rather than laser wavelength. Laser pulse duration may be in nanoseconds or picoseconds. (**Diels & Rudolph, 2006).**

Cavitation and jet forming can also occur where breakdown happens within soft tissues or fluids. The optical breakdown's most notable aspect is that

it allows for energy deposition in both weakly absorbing media and pigmented tissue without relying on laser wavelength. ( **Niemz, 2004**)

Where suitable laser parameters are used, Plasma-induced ablation will result in highly clean and well-defined tissue loss with no indications of thermal or mechanical damage. For picosecond or femtosecond pulses, high peak intensities can be achieved with much lower pulse energies. Optical breakdown can also be performed with these very short pulse durations while greatly decreasing plasma energy and destructive effects. During photodisruption, mechanical forces divide the tissue, Plasma-induced ablation, on the other hand, is spatially limited to the breakdown field. Even at very high thresholds, optical breakdown is often synonymous with shock wave production for nanosecond pulses. (**Niemz, 2004), (Clarkson, 1992**)

## 1.20 Laser Safety Standards and Hazard Classification

The potential for causing acute damage to the eye or eyes, as well as the potential for causing fires from direct contact to the beam or reflections from reflecting surfaces, is used to classify lasers. Labels affixed to commercially manufactured lasers are used to classify and identify them. If the laser was made on campus or is otherwise unlabeled, the LSO should be consulted on the appropriate laser classification and labeling. (**Laser Safety Handbook. Northwestern University Office for Research Safety 2**)

Lasers are classified using the physical parameters of power, wavelength, and exposure duration.Emitting laser radiation at amounts that could cause eye or skin injury.. A description of laser classes is as follows: **(American National Standard for Safety Use of Lasers; ANSI Z136.1-2014)**

- Class 1M: When observed by optical devices such as an eye-loupe or telescope, a laser or laser device is deemed incapable of providing dangerous exposure.

- Class 2: Since lasers emit detectable wavelength radiation and are unable to cause eye or skin damage within the time frame of the human eye blink reflex (aversion response to light equal 0.25 seconds), staring at laser beam class 2 should be prevented.

- Class 2 M: The visible part of the electromagnetic spectrum is emitted by laser radiation. Since the blink reflex usually protects the eye, this laser class is considered potentially dangerous when seen with such optical aids.

- Class 3R: This laser designation was potentially dangerous under any direct & specular reflection vision if the eye was sufficiently concentrated & steady. Laser radiation is released in the visible (400-700 nm) & invisible (<400nm and >700nm) regions.

- Class 3B: The apparent unseen region of the spectrum is illuminated by the medium-powered laser. For both direct and specular conditions, these medium-powered lasers pose a possible eye threat. Except for extremely powered 3B lasers working at a certain wavelength, class 3B lasers do not pose a diffuse or skin threat. .

- Class 4: Both dental and medical surgical lasers, as well as high-powered lasers that emit laser light in the fluorescent or visible region of the spectrum, pose a direct or diffuse acute threat to the eye and skin. These lasers often pose a risk of fire and byproduct leakage from the target or manufactured material.

## 1. 21 Hazards of Laser Radiation and its Biological Effects

When a laser ray strikes the human body, some of the light is reflected by the tissues. The absorbed radiation will cause damage if the irradiance (power

density= Watt/cm2) is high enough. The eyes and skin are two areas of the body that are most vulnerable to laser radiation damage. (**Donges & Noll, 2015**).

Biological effects from laser radiation are based on the radiant exposure, wavelength, source size, exposure time, environmental conditions, and individual susceptibility. **(Laser Safety Manual. University of Missouri - Columbia. 2007; Revision1.)**

### 1.21.1 Laser Radiation Effects on Eye

Laser light can cause damage to various areas of the retina. The wavelength has an effect on the injury. Retinal burns can occur in the visible (400-700 nm) and near-infrared (700-1400 nm) wavelength ranges, resulting in partial or full blindness. The eye may concentrate the laser beam or specular reflection on a tiny spot on the retina at these wavelengths. The irradiance of the beam would be increased by a factor of 100,000 as a result of this focusing. The cornea is damaged by laser radiation in the ultraviolet (400 nm) and infrared to far-infrared (> 1400 nm) areas of the spectrum. In the near-ultraviolet range (315- 400 nm), some of the radiation can reach the lens of the eye. (**Donges & Noll, 2015**).

If there is inadequate energy accumulation, cell loss and vision degradation, the cornea and lens tissues are less likely to be affected than the retina. If the proper optical density is used and the eyewear is worn, it can be a very powerful control. **(Laser Safety Manual. University of Missouri - Columbia. 2007; Revision1.), (Niemz, 2004)**

### 1.21.2 Laser Radiation Effects on Skin

With the exception of high-power infrared lasers, skin effects are usually regarded as secondary. Skin effects have become more important as the lasers that emit in the UV spectral range has expanded. Emissions in the 200 to

280 nm range cause erythema (sunburn), skin cancer, and accelerated skin ageing. Exposure to light with wavelengths of 280 to 400 nm causes increased pigmentation. The skin has been photosensitized after being exposed to light with wavelengths ranging from 310 to 700 nm. Depending on the power density and exposure time, lasers emitting visible and infrared radiation cause reactions ranging from slight reddening to blisters and charring. These problems are usually resolved or unresolved. However depigmentation, ulceration, and scarring of the skin and damage to underlying organs may occur from extremely high powered lasers. **( Sliney & Wolbarsht, 2003), (Niemz, 2004).**

## Aim of the Study

The aim of the present study was to evaluate the efficiency of diode laser 980 nm in performing lip reposition in comparison to conventional surgical technique depending on clinical observation and patient outcome.

# CHAPTER TWO

# MATERIALS AND METHODS

## 2.1 Introduction

This chapter contains a detailed explanation of the materials, patients, and

## 2.2 Materials

**Equipment and materials:**

Surgical kit used in lip reposition by scalpel as shown in Fig (2-1)

- Diagnostic instruments (mirror, probe, twizer), (Pakistan)
- Periodontal probe (Den tag, Italy)
- Dental syringe (Germany)
- Disposable dental needle (UK)
- Local anesthesia cartilage (septodont, France)
- Chlorhexidine mouth rinse (UK)
- Normal saline (Turkey)
- Surgical blade no.12 (Germany)
- Scissor (Dent tag, Italy)
- Needle holder (Dent tag, Italy)
- Cotton (Turkey)
- Gauze (Turkey)
- A sterile, disposable, marker pen (UK)
- Silk 3-0 suture. (China)

As in figure below:

**Figure (2-1**): Surgical kit used in the scalpel lip repositioning

Surgical kit used during lip reposition by laser as shown in Fig (2-2):

- Diode laser (810, 980 nm) (QuickLase dentalase ,United Kingdom)
- Laser protective goggles supplied with laser system.
- Disposable laser tips 300µm
- Diagnostic instruments (mirror, probe, twizer), (Pakistan).
- Disposable syringes (china)
- Periodontal probe (Den tag, Italy)
- Dental syringe (Germany)
- Disposable dental needle (UK)
- Local anesthesia cartilage (septodont, France)
- Normal saline (USA)
- Cotton role (UK)
- Gauze (UK)
- Silk 3-0 suture (China)
- Scissor (Dent tag, Italy)
- Needle holder (Dent tag, Italy). As in figure (2-2)


**Figure (2-2):** Surgical kit used during laser lip reposition

### 2.3.1 Laser System and Parameters

Diode laser, 980+_10 nm (QuickLase dentalase ,United Kingdom) system was used in this study. It's a surgical & therapeutic device that may be used for a range of soft-tissue operations, dental whitening, & the temporary relief of mild discomfort. The tips are single-use accessories with core diameters of (200µm 400µm) & various lengths. In the front of the console is a Display Panel (Touch Screen and Control Button). An external mains power supply can be used to power it. Once the desired setting selected( power selection, mode of radiation continuous or pulsed, pulse duration) turn on the ready mode and the laser energy emits by pressing down a foot switch.

Laser device and its protective goggles are shown in Fig (2-3). applies 2.5W Power, Continues Wave mode (CW) and tip diameter was 300 µm with tips length of 4 mm.


**Figure (2-3)**: Laser system with goggles

### 2.3.2 Laser System Specifications

Active medium: which consists of Semi-conductor chips made from Gallium Aluminium Arsenide referred to as AlGaAs.. They are activated or pumped by an electrical current through the diode to produce an elliptical shaped display of monochromatic light that can be focused into a very small point and coupled into a delivery fiber. The wavelenghth produced by diode is approximately 810nm & 980 nm. the laser is an infrared invisible non_ionising cold emitter radiation that does not create change in cellular DNA. The dentaLase unit is an air _fan _cooled device. For an emergency and normal stop, the diode features two ways. (**British institute of Laser Dentistry)**

To stop energy flow if operater wants to deactivate the laser. Ether of the following two methods can used to shut down the laser.

1-press the red stop button on the front panel or turn off on the back of the unit.

2_Simply disconnect the power lead from the back of the laser.

- Weight: <1.8 kg
- Wavelength: Dual models 810 ± 10nm, 980 ± 10 nm

- Power Output :3_8w 0.1w to 8w 6_12w D 0.1w to 12w (model dependent)
- Cumulative measurement uncertainty : ± 0.05w
- Operation Modes: Continuous and Pulsed at 10, 20, 50Htz and adjustable.
- Aiming beam:650nm diode laser, < 1mW output, class 1
- Beam divergence angle of laser radiation : 0.22 radiance
- Built _in system warning and automatically cut off the laser output to protect the laser diode when the temperature is too high.
- Dimentions : depth<19cm,width<18.5,height<14.5
- Laser Classification: diode laser, class IV
- Fiber Tips Diameter: 200μm_400 μm bendable tip.

## 2.4 Patients

Forty patients were included in study (34 female and 6 male) with age range between (18 to 38 years) old and mean age of (28). All patients' required surgical treatment of gummy smile, the surgical treatment was decided after clinical oral examination. Some Patients treated by conventional method using scalpel, while the other patients treated by using diode laser 980 nm. The study was carried out from October 2020 to September 2021.

**`Patients` divided into two groups:**

**Group A:** The control group includes 20patients treated with conventional surgical technique by using scalpel (blade no.12)

**Group B:** The study group included 20 patients treated by using diode laser 980nm (QuickLase dentalase ,United Kingdom)

### 2.4.1 (Inclusion Criteria)

- Patients ages between (18 – 35) years old.
- Periodontal health is indicated by; the gingival inflammatory score, bleeding score, & the probing depth of gingival pockets.
- Patients who are in good health or who have a controlled systemic illness.
- Gingival exposure ranging from (4 - 6 mm), due to short upper lip & hyperactive lip elevator muscles (lip mobility <8mm).

### 2.4.2 (Exclusion Criteria- The Rejection Criteria )

- Heavy Smokers.
- Pregnant ladies & breast feeding ladies are two of the most vulnerable group.
- Attached gingivae of < 3 mm, which may trigger flap difficulties construction, stabilization & suturing.
- Vertical maxillary excess > 6 mm.
- uncontroll Systemic diseases.

### 2.4.3 Patient Case Sheets

Case sheet recorded for each patient in this study, it used to record the medical and dental history ,to record the recall visits as well as the patient questionnaire (as shown in Appendix I) that used to record the pain and discomfort, bleeding, oedema, function and satisfication depending on daily bases.

### 2.4.4 Patients Preoperative Assessment:

Full medical and dental history were taken from the patients. Oral hygiene instructions given to the patients. A prophylaxis session was conducted one week previous to the start of the procedure (mechanical treatment). During an active smile, the amount of gingival display from the upper lip's

inferior edge to the gingival edge of the central incisor, as well as the gingival margins of the left & right 2nd premolars' mid-buccal gingival margins, were measured with a mm ruler & recorded to the nearest millimeter at baseline (before surgery) & (after surgery). The quantity of gingival display is set to zero when the lip covers a portion of the clinical crown (postoperatively). Every measurement is measured to the millimeter.

### 2.4.5 Clinical Evaluation Scores

This study designed to compare esthetic treatment of gummy smile by using diode laser 980nm and traditional scalpel surgical technique. For the comparison of two techniques, the following clinical parameters were assessed:

- *Bleeding* was assessed according to the following score: 0. No bleeding, 1.mild bleeding, 2.moderate bleeding, 3.sever bleeding.
- *Pain* was assessed according to the following score: 0.no pain, 1.mild pain, 2.moderate pain, 3.sever pain.
- *Oedema* was assessed according to the following score: 0.No oedema 1.mild oedema 2. Moderate oedema, 3.severe oedema.
- *Function* was assessed according to the following scor: 0.no function interference, 1.mild function interference, 2.moderate function interference, 3.sever function interference.
- *Overall satisfaction* was assessed according to the following score: poor(%): 0-25` fair(%): 26-50` good(%): 51-75` excellent(%): 76-100.

## 2.5 Conventional Surgical Technique:

The surgical site was anesthetized using infiltrated local anesthesia (Lignospan Special. Lidocaine 2% with adrenaline (epinephrine) 1:80,000, 2.2 ml of solution per cartridge, septodont, France. The incision outlines were outlined on the dried mucosa with a sterile surgical marking marker. From the mesial line angle of the right upper 1st tooth to the mesial line angle of the left

upper 1st molar, a full thickness horizontal cut (one mm) is created coronally to the mucogingival junction (MGJ), repeatedly with a V fashion incision in the upper lip frenum region. A 2nd lateral cut is performed. Make an incision in the labial mucosa (ten to twelve mm) apically to the initial incision. To create an elliptical outline, At the mesial line angles of the right upper 1st tooth & the left upper 1st molar, the two parallel horizontal cut are joined. A full thickness dissection was used to extract the mucosa. Bone was used to dissect the perioral musculature. The quantity of The sum of gingival display excised was roughly 2x that of the gingival display (maximum tissue thickness: 10-12 mm). Muscle layers were sutured to approximate the two incision lines. At the midline and other positions along the incision's margins, Disrupted stabilization sutures (silk 3/0) were used to suture the mucosa. To establish the new mucosal border to the gingiva and to approach both flap ends, interrupted sutures were used as in (Fig. 2-4) (Fig. 2-5).

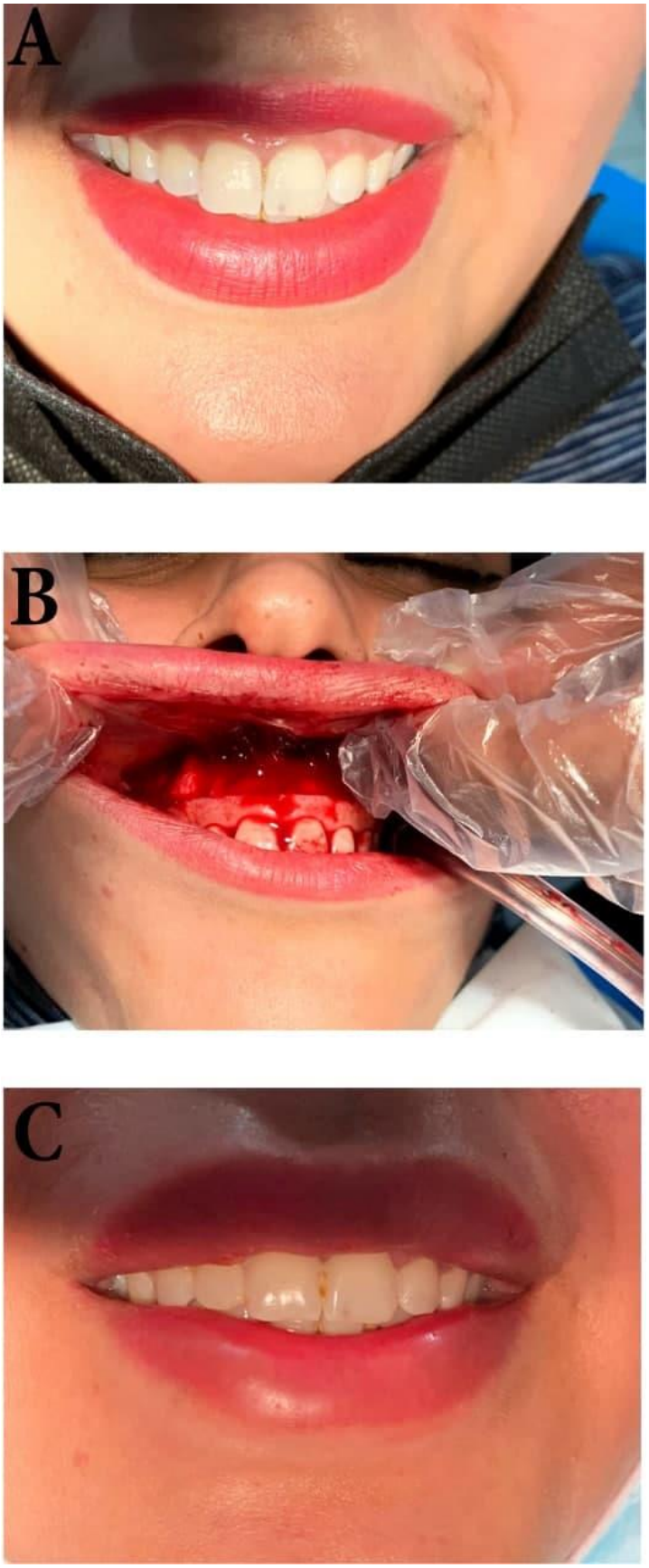



**Figure (2-4)**: Scalpel lip repositioning A, Before treatment. B, After tissue excision C, At end of treatment.

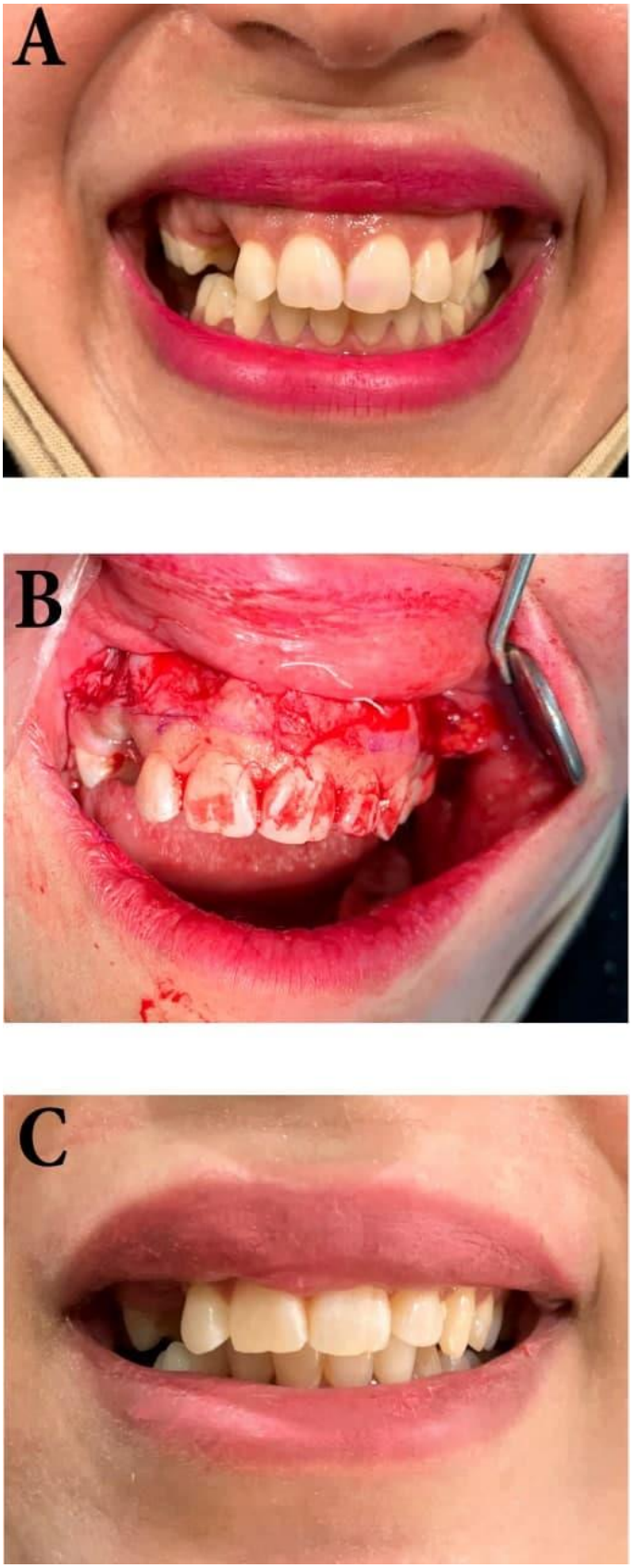



**Figure (2-5):** Scalpel lip repositioning A, Before treatment. B, Removed the outlined tissue. C, At end of treatment.

## 2.6 Laser Surgical Technique:

### 2.6.1 Fiber Initiation/Carbonising paper

The new laser fiber tip will not cut until the fiber end has been initialised by carbonizing. The easiest way to do this is to start lasing on piece of black carbon paper or white paper on top of black ink while holding the pen at about 60 degree angle .Once the tip burns the paper the tip is now ready as shown in Fig (2-6). To check try lasing white paper. Recarbonise if necessary.

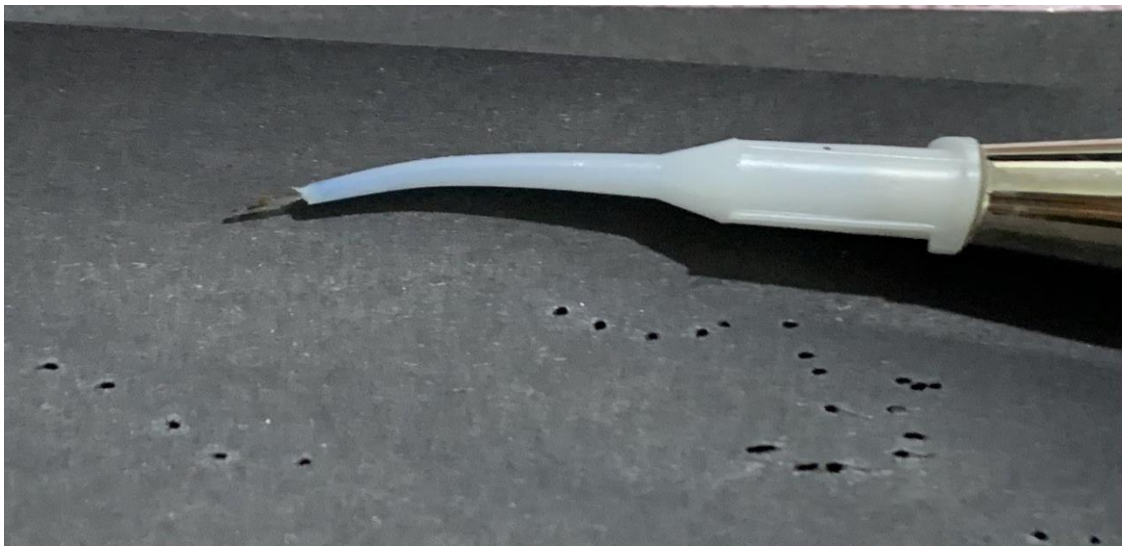


**Fig (2-6):** Initialised laser fiber tip

Safety glasses were worn by the operator, the patient, and the helper. Instruments with mirrored surfaces or highly reflective surfaces were avoided since the laser beam might be reflected. It was taken care not to use the laser in the presence of explosive gases. Local infiltration was used to achieve anesthesia (2 percent lidocaine with 1:100.000 epinephrine). Laser dots were used to define the surgery region. The procedure began with a full-thickness incision following the mucogingival junction extending from the right 1st molar to the left 1st molar using a diode laser with a wavelength of 980nm (QuickLase dentalase, United Kingdom), 2.5W power, continuous wave (cw)

mode, & 300mm tip (QuickLase dentalase, United Kingdom). On the opposite side, the operation was repeated. Following the vertical laser incisions, a 2nd horizontal incision 10–12mm apical to mucogingival junction is performed in the labial mucosa, parallel to the 1st. An oval design was used to link the two laser incisions at either (To make the edges of the wound close for ease of stitching). The full-thickness flap was removed, revealing the underlying bone in the mouth. Laser dissection is used to remove the indicated mucosa strip, exposing the bone.

The periosteum is not damaged by the diode laser, but minor horizontal motions must be made to avoid heat damage. The new mucosal boundary to the gingiva was then stabilized with 3-0 sutures. Three days, one week, two weeks, three weeks, and four weeks following surgery, patients were called to report any postoperative problems. .

Excision of a full-thickness flap should be equal to or more than the amount of gingival display that must be decreased, with a maximal tissue excision of (10-12mm). To prevent involving the labial minor salivary glands, which might lead to the development of a mucocele, caution must be exercised. During the surgery, an assistant was asked to hold the suction tips near the surgical site to suck any smoke or odor that may result from laser tissue incision, continues irrigation with normal saline in order to cool the tissue as well for cleaning of the surgical site. Wet gauze was used to remove the tissue debris from the surgical site and from the tip. The laser was stopped every 20sec in average to check the gingival tissue and to avoid excessive heat accumulation. the suture was removed after 21 days postoperatively to ensure adequate healing and proper lip positioning without any complications and collateral infections as in (Fig. 2-7) (Fig. 2-8).

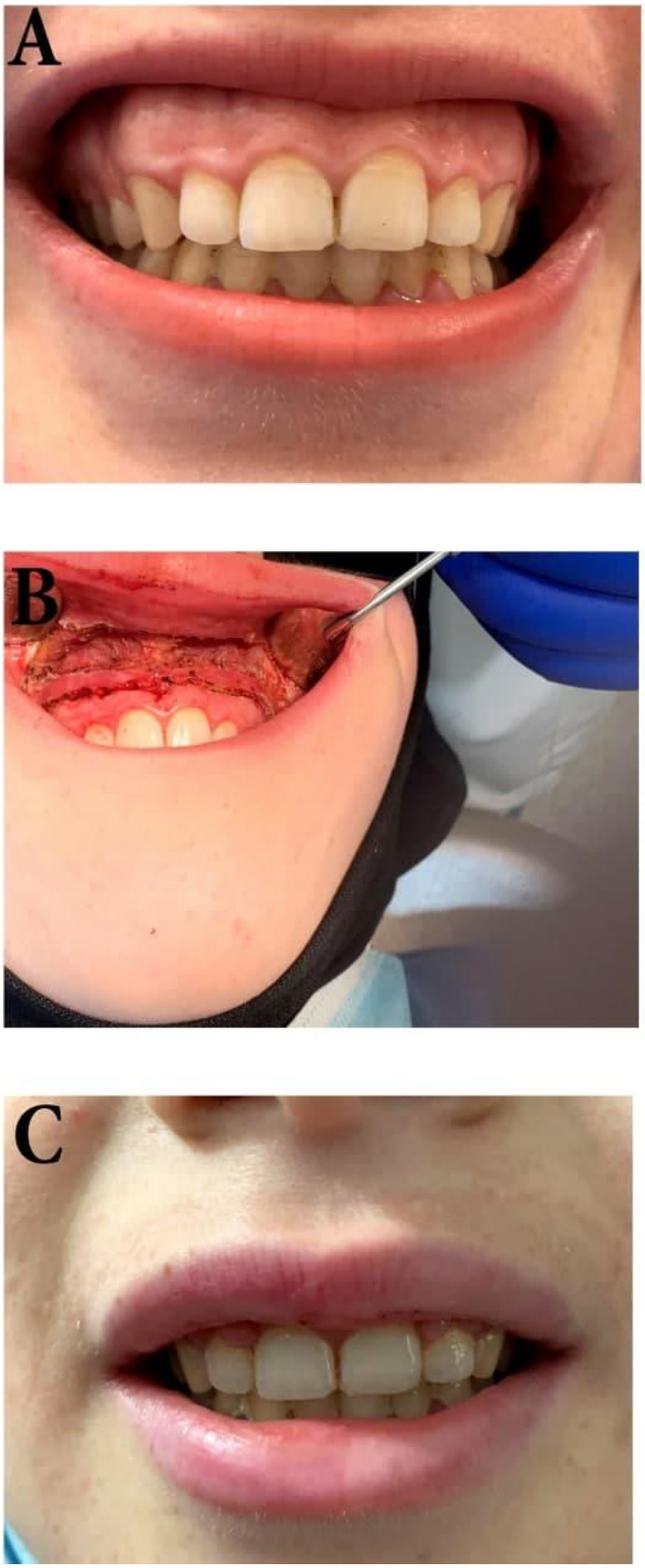



**Figure (2-7)**. A, Preoperative anterior view of the patient. B, Removal of the excised gingival tissues with little bleeding. C, At end of treatment.




**Figure (2-8).** A, Preoperative anterior view of the patient. B, Removal of the excised gingival tissues with little bleeding. C, At end of treatment.

## 2.7 Postsurgical Instructions

For one week, patients are given ibuprofen tabs as needed and instructed to rinse twice daily with 0.12% chlorhexidine. They are also instructed to eat only soft foods for the 1st week following surgery to avoid further mechanical injury to the treated regions, as well as to keep their lips still when smiling or talking for the 1st two weeks.. For many hours, apply cold packs to the upper lip. No cleaning around the surgical site for 2 weeks.

## 2.8 Postoperative Clinical Assessments

### 2.8.1 Assessment of Pain and Discomfort

- 0. No pain,
- 1. Mild pain,
- 2. Moderate pain,
- 3. Sever pain.

### 2.8.2 Assessment of bleeding

- 0. No bleeding,
- 1. Mild bleeding,
- 2. Moderate bleeding,
- 3. Sever bleeding.

### 2.8.3 Assessment of Oedema (Swelling)

- 0. No oedema
- 1. Mild oedema
- 2. Moderate oedema,
- 3. Severe oedema.

### 2.8.4 Assessment of function interference as;

- 0. No function interference,
- 1. Mild function interference,
- 2. Moderate function interference,
- 3. Sever function interference.

### 2.8.5 Assessment of overall satisfication as;

- Poor(%): 0-25`
- Fair(%): 26-50`
- Good(%): 51-75 `
- Excellent(%): 76-100`

## 2.9 Safety Measures:

The eye and skin must be protected from direct and reflected tissue radiations, wearing goggles that specified with laser system for patient, operator and assistant. Surgical sucker was used to capture the smoke in the surgical site. The laser can ignite non_metallic materials. All combustible materials must be removed from operation area or should be kept moist during the procedure. the laser can ignite prepration solutions containing alcohol and /or acetone.

## 2.10 Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 25 is used to interpret the data. The information is given in the form of a mean, standard deviation, and ranges. Frequencies and percentages are used to display categorical data. The continuous variables were compared using an independent t-test. The Chi square test is performed to determine the relationship between provisional diagnosis and specific data, When the predicted frequency was less

than 5, the fisher exact test was employed instead. Significant was defined as a P – value equal or less than 0.05.

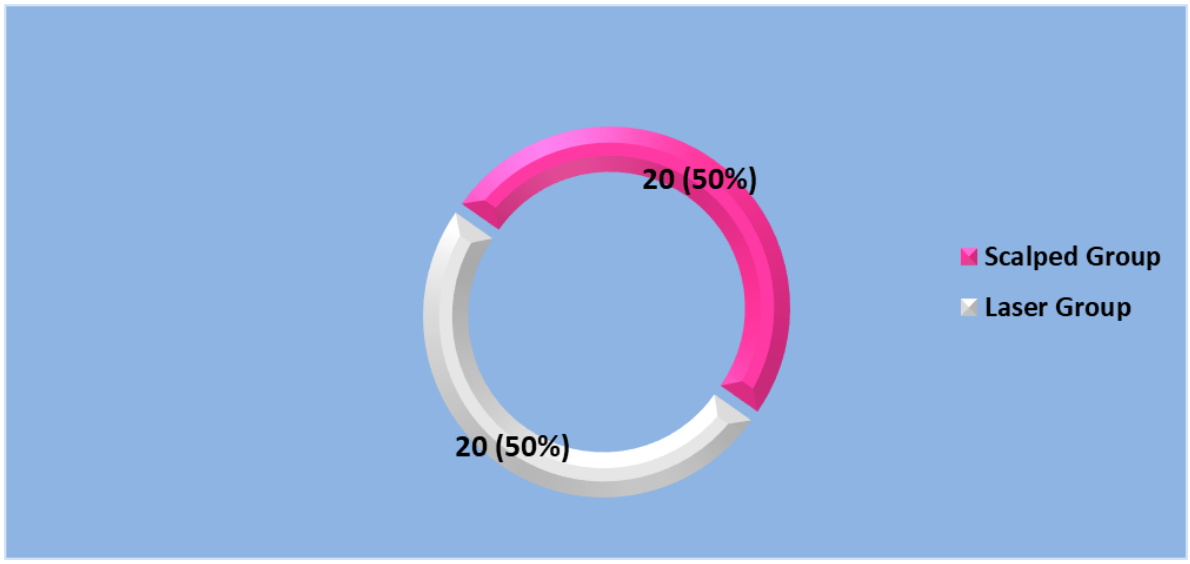
# CHAPTER THREE

## RESULTS, DISCUSSION AND CONCLUSIONS

# RESULTS

This chapter includes the results of this research work, discussion of our study, conclusions and the future work also will be mentioned.

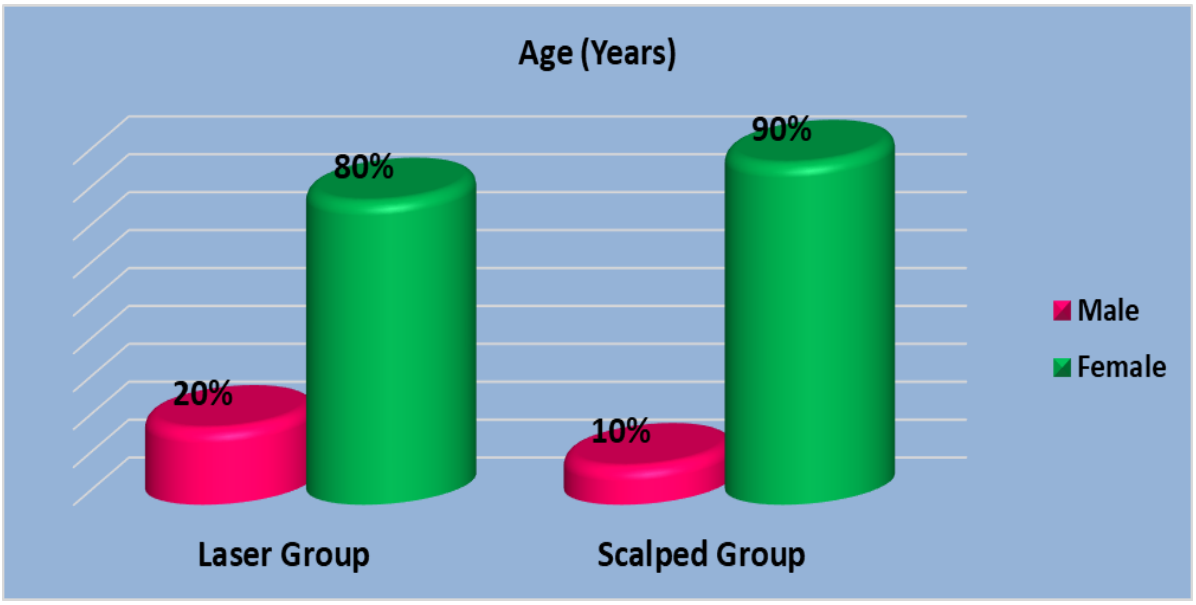
For this investigation, a total of 40 patients were joined For the repair of a gummy smile, they all had surgical lip repositioning procedures. They were allocated equally into two groups to treated with either diode laser procedure (Laser Group) or scalpel procedure (Scalpel Group) as in (Fig. 3-1).




**Figure(3-1):** Study groups

## 3.1. Age and gender

In laser group, patients' age ranged from (18- 37 years old) with a mean of 26.55 &( standard deviation) (SD) of ± 4.87 years, and 12 (60%) of patients aged ≥ 25 years. In scalped group, the age ranged from (15 _ 35 years) with a mean of 26.40 ± 6.10 years, and the cases were distributed equally between the age groups, 10 (50%) in each group as in (Fig 3-2). Regarding gender, in laser and scalped groups, proportion of females was higher than males (80% versus 20%) and (90% versus 10%), respectively as in (Fig 3-2).



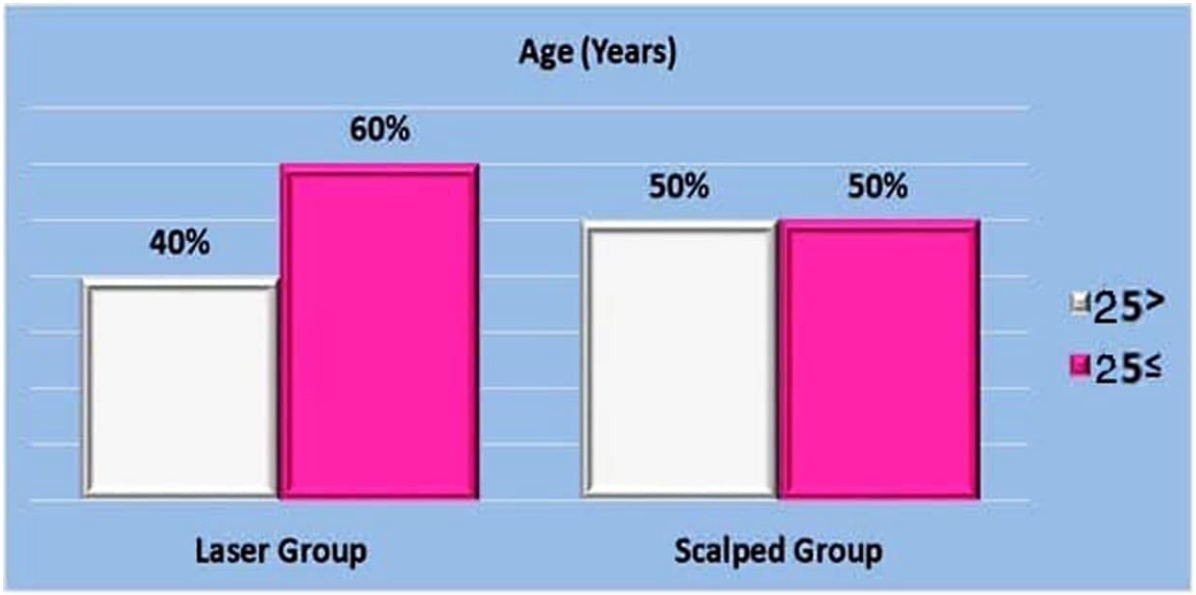




**Figure (3-2):** Distribution of study patients by age & gender

There are no statistically significant variances between the study groups in relations of age (P= 0.932) & gender (P= 0.376) (Table 3-1).

**Table (3-1):** Relationship between the study groups by age & gender

| Demographic Data | Study Groups | | | P – Value |
|---|---|---|---|---|
| | Laser Mean ± SD | Scalped Mean ± SD | | |
| Age (Years) | 26.55 ± 4.87 | 26.40 ± 6.10 | | 0.932 |
| | | | | |
| Gender | no. (%) | no. (%) | no. (%) | |
| Male | 4 (20.0) | 2 (10.0) | 6 (15.0) | 0.376 |
| Female | 16 (80.0) | 18 (90.0) | 34 (85.0) | |

## 3.2. Comparison between the study groups by postoperative pain, bleeding, edema, and function

### 3.2.1. Pain

In the current study, the postoperative pain score showed a statistically significant difference between both techniques. The pain score is significantly lesser in laser group than in scalped group at third day (0.55 vs 1.90, P= 0.001), at first week (0.25 vs 1, P = 0.001), & at second week (0 vs 0.55, P = 0.001). Both laser and scalped groups had no pain at forth week (Table 3.2).

**Table (3-2):** Comparison between the study groups by means of pain score at three days, one week, two weeks, and four weeks after operation

| Postoperative Pain | Study Groups | | P-Value |
|---|---|---|---|
| | Laser Mean ± Std. Dev | Scalped Mean ± Std. Dev | |
| Day 3 | 0.55 ± 0.68 | 1.90 ± 0.30 | **0.001** |
| Week 1 | 0.25 ± 0.55 | 1 ± 0 | **0.001** |
| Week 2 | 0 | 0.50 ± 0.51 | **0.001** |
| Week 4 | 0 | 0 | - |

### 3.2.2. Bleeding

At third day, the bleeding score is significantly lesser in the laser group related to the scalpel group (0 vs 1.2, P= 0.001). Patients in the laser and scalped groups didn't develop bleeding at first week, second week, and forth week (Table 3.3).

**Table (3.3):** Comparison between the study groups by means of bleeding at three days, one week, two weeks, and four weeks after operation

| Postoperative Bleeding | Study Groups | | P – Value |
|---|---|---|---|
| | Laser Mean ± Std. Dev | Scalped Mean ± Std. Dev | |
| **Day 3** | 0 | 1.2 ± 0.41 | **0.001** |
| **Week 1** | 0 | 0 | - |
| **Week 2** | 0 | 0 | - |
| **Week 4** | 0 | 0 | - |

### 3.2.3. Oedema & Swelling

It was clear that, there is a statistically significant variance in postoperative edema between the study groups. The swelling was significantly lower in laser group compared to scalped group at third day (0.9 vs 1.8, P= 0.001). The difference in swelling between both techniques was not significant at first week (P= 0.086) and at second week (P= 0.56). At forth week, no swelling was seen among the patients in both groups (Table 3-4).

**Table (3-4):** Comparison between the study groups by means of swelling at three days, one week, two weeks, and four weeks after operation

| Postoperative Edema | Study Groups | | P-Value |
|---|---|---|---|
| | Laser Mean ± Std. Dev | Scalped Mean ± Std. Dev | |
| **Day 3** | 0.9 ± 0.71 | 1.8 ± 0.41 | **0.001** |
| **Week 1** | 0.3 ± 0.57 | 0.6 ± 0.5 | **0.068** |
| **Week 2** | 0.05 ± 0.22 | 0.1 ± 0.3 | **0.56** |
| **Week 4** | 0 | 0 | - |

### 3.2.4. Function

In this study, a statistically significant difference was found between the study groups in regards to postoperative function score. The function score was significantly higher in scalped technique as compared to laser technique at third day (2 vs 1.05, P= 0.001), first week (1 vs 0.7, P= 0.048), and at second week (0.7 vs 0.15, P= 0.001). Both laser and scalped groups had score zero of function interference at forth week (Table 3-5).

**Table (3-5):** Comparison between the study groups by means of function score at three days, one week, two weeks, and four weeks after operation

| Postoperative Function | Study Groups | | P-Value |
|---|---|---|---|
| | Laser Mean ± Std. Dev | Scalped Mean ± Std. Dev | |
| **Day 3** | 1.05 ± 0.68 | 2.0 ± 0 | **0.001** |
| **Week 1** | 0.7 ± 0.47 | 1.0 ± 0.45 | **0.048** |
| **Week 2** | 0.15 ± 0.36 | 0.7 ± 0.47 | **0.001** |
| **Week 4** | 0 | 0 | - |

## 3.3. Patient Satisfaction Score (PSS)

Regarding PSS about laser and scalped procedures, good satisfaction was reported by the highest proportion of patients in both groups, 70% of laser group and 80% of scalped group. In this study, no significant association (P= 0.716) was found between the study groups in regards to PSS (Table 3-6).

**Table (3-6):** Distribution of the study groups by mean function at three days, one week, two weeks, and four weeks after operation

| PSS | Study Groups | | Total (%) n= 40 | P - Value |
|---|---|---|---|---|
| | Laser (%) n= 20 | Scalped (%) n= 20 | | |
| **Fair** | 1 (5.0) | 0 (0) | 1 (2.5) | **0.716** |
| **Good** | 14 (70.0) | 16 (80.0) | 30 (75.0) | |
| **Excellent** | 5 (25.0) | 4 (20.0) | 9 (22.5) | |

## 3.4 Discussion

Lasers in dentistry are used in a variety of ways. Soft tissue surgery and lesions ablation are two of these uses. ( **Azma & Safavi, 2013**)

The quantity of energy absorbed by biological tissue is determined by tissue properties such as tissue chromophores or pigment, as well as the wavelength of the laser. Water molecules or macromolecules like proteins and other tissue pigments like melanin and hemoglobin might be the chromophores. Each laser has a unique wavelength that affects the target tissue's interconnected components, such as vascularity; chemical composition and water content. (**Fontana et al., 2004**)

In general, hemoglobin and other tissue pigments absorb lasers with shorter wavelengths (in the visible and near IR areas, from 500-1000nm), whereas water and hydroxyapatite absorb lasers with longer wavelengths. (**Coluzzi, 2004**).

Diode lasers come in a variety of wavelengths and may be used in either continuous or pulse mode. Melanin and hemoglobin, which are the primary components of soft tissue, absorb these wavelengths well. As a result, diode lasers can be utilized for incision, excision, coagulation, and pain relief; the penetration depth is estimated to be between 0.5 and 3mm (**Fornaini et al., 2007)**. Diode lasers can absorbed by hemoglobin and melanin selectively so that they are safe to use around dental hard tissue and dental implants. (**Cobb, 2006)**.

The underlying mechanism of surgical lasers is photothermal interaction, in which light energy is converted into heat energy when it is absorbed by biological tissue, resulting in structural changes inside the tissue. These thermal activities, which vary from coagulation to tissue incision and ablation, will be

governed by laser settings, laser type, and tissue characteristics. **(Niemz, 2004) (Kishen &Asundi, 2009)**

The aim of the study is to characterize the efficiency a diode laser 980 nm in performing lip reposition in comparison to the conventional scalpel technique for treatment of gummy smile. The comparison was depended on different clinical criteria that included postoperative pain and discomfort, bleeding, swelling, function interference and overall satisfication. The results of this study suggest the diode laser surgery was effective in the treatment of gummy smile. The finding contradicts several other study findings in the literature, which suggest that patients treated with diode lasers have reduced postoperative discomfort. The development of protein coagulum, which acts as a biological dressing and shuts off nerve endings, might explain this. **(Kravitz & Kusnoto, 2008) (Elanchezhiyan et al., 2013) (Laser Safety Manual, 2007; Revision1).**

our result in a good agreement with that reported by Amaral et al. **(Amaral et al., 2015)** who used diode laser 808nm compared to the scalpel in the treatment the fibrous hyperplasia without significant variations in postoperative pain within the two techniques.

The current study found a substantial difference in the quantity of local anesthetic required during laser surgery compared to the scalpel group, with significantly less being required during laser surgery. These findings are consistent with those published by Ize-Iyamu IN et al. **(Ize-Iyamu et al., 2013)** who used diode laser 810nm and scalpel in orthodontic soft tissue surgical procedure. This may be explained by rapid cell vaporization as well as the biostimulating and biomodulating abilities of diode laser that reduced the need for local anesthesia. (**Gianfranco et al., 2010**)

our study, diode laser surgery produced excellent hemostasis and good visibility of the operative field when compared to knife surgery. These findings are consistent with those published by Amaral et al. **(Amaral et al., 2015)** and **(Coleton, 2004)** One of the characteristic differences between laser and the scalpel is the generation of coagulated tissue layer along the incision line **(Watanabe et al., 1996**)

The temperature of biological tissue rises once laser light is absorbed by it. When the temperature exceeds 60 degrees Celsius, coagulation occurs; this phenomenon is critical in the surgical use of lasers because photo-coagulation causes protein, enzyme, and other bioactive molecules to denaturate instantly. The primary physical event that will lead to collagen fiber shrinkage when the irradiated tissue constricts against the proximal vasculature is the alteration in the molecular structures of tissue collagen, and the shrinkage of the collagen in the walls of blood vessels will enhance hemostasis. Laser damage to erythrocytes increases platelet aggregation, which promotes intraluminal thrombosis, further decrease in the blood loss. (**White et al,. 1991**)

This explains why the laser group had less blood loss than the scalpel group. In comparison to other types of lasers such as CO2 lasers, diode lasers are significantly absorbed by hemoglobin and melanin, allowing accurate cutting of soft tissue with good homeostasis and deep penetration. This lowered operation time and postoperative bleeding. **(Amaral et al., 2015)** in contrast this result disagree with result reported by El-Kholey KE **(El-Kholey, 2014**) During the second implant procedure, they found no significant difference between the diode laser 970nm (with a power setting of 4 W, a continuous emission mode, and a 320 mm optic cable) and the surgical blade. This might be explained by the fact that diode lasers simultaneously ablate tissue and shut blood vessels, resulting in a bloodless surgical field and shorter operation times While

adequate hemostasis cannot be achieved with a scalpel, lip reposition with a surgical blade requires more tools and stages to complete.

our study shows significant difference in function interference between laser group and conventional group with lower degrees of inflammation and better clinical healing seen in patients treated with diode laser 810, 980 nm. our result agrees with result reported by Evans DH et al. (**Evans & Abrahamse, 2008)** Their research focused on the biological responses of the healthy & injured human skin fibroblasts to helium-neon (632.8nm), diode (830 nm), & Nd:YAG 1064nm (laser radiation utilizing a single contact of (5) or 16 J/cm2) lasers. and result reported by Elanchezhiyan S et al **(Elanchezhiyan et al., 2013)** In the treatment of hereditary ankyloglossia, researchers compared diode laser (980nm diode laser, fitted with a flexible optical cable with replaceable 400 micron tip, continuous mode of radiation, and power setting of 1–1.5 W) to traditional surgery.

This might be explained by enhanced collagen fiber production with fewer myofibroblasts, resulting in reduced wound contraction and scar formation; moreover, laser sterilizes the surgical field during tissue ablation, enhancing the environment for improved tissue recovery. (**Durham, 2009).**

A person's personality would not be complete without a smile. A winning smile is associated with intelligence and achievement, Despite the fact that a gummy smile is a very demanding cosmetic concert for many patients. The most contentious aspect of treating a gummy smile is determining a correct dia gnosis. If that's finished, the recovery strategy can be predicted becomes easier.(**Sildeberg et al., 2009), (Isiksala et al., 2006), (Aldelaimi and Mahmood, 2014).**

Alternative therapies for those with severe gingival presentation or a gummy grin include reverse vestibuloplasty (lip repositioning), botulinium

toxin injections, and orthognathic surgical procedures. Reverse vestibuloplasty was used to treat patients with excessive gingival presentation or gummy smiles in this study, which was deemed to be comparatively minimally invasive, stable, accurate, and comfortable for the patient's approval, with a quick and straightforward surgical procedure (lasting just a few minutes), is cost-effective, does not necessitate hospitalization, and has no side effects. **(Roberto et al., 2008).**

All of the patients were pleased with the outcome. There were no postoperative problems such as infection or loss of muscular strength in any of the patients. All of the writers agree that LRT is a good choice for the treatment of EGD that produces positive outcomes. **(Vergara-Buenaventura et al., 2020).** The optimum gingival exposure when smiling, according to Peck et al., is 1 to 2mm. **(Peck et al., 1992),** Because the upper lip tends to elongate with age, these findings imply that this procedure is effective. Overcorrection is not recommended. **(Rees & Trenta, 1994).**

This study followed the guidelines of Tawfik et al's modified method, which recommends removing twice as much tissue as the amount of gingival display (maximum 12 mm). **(Tawfik et al., 2018).**

After flap reflection, the muscle connection was not severed in the original procedure. Other writers advocated for myectomies to remove the connection of the smiling muscle. Myectomies were chosen because they allowed for tension-free suturing and prevented relapse. **(CachayVelasquez, 1992), (Litton & Fournier, 1984)**

Various methods have been published in order to minimize problems associated with the recurrence of GS. Ellenbogen and Swara reported the first recurrence following surgery, with partial relapses occurring three months after surgery. They proposed the use of alloplastic spacers to prevent the levator labii superioris from reuniting. **(Ellenbogen & Swara, 1984)**.

Only three trials with a longer follow_up period than one year were discovered, and they only demonstrated stability in gingival reductions for up to six months. **(Bhola et al., 2015), (Ribeiro-Júnior et al., 2013), (Ishida et al., 2010).**

The authors feel that the problems associated with a GS relapse & reappearance are caused by the upper lip not being stationary during the healing process. (**Silberstein et al., 2018).**
Alammar confirmed that the recurrence might be caused to muscles attempting to resume their pre-surgery activity. (**Alammar et al., 2018).**
Some writers decided to use the Aly and Hammouda's combination approach. **( Aly & Hammouda, 2016)**. BTI was utilized as an adjuvant treatment to ensure and improve long-term surgical outcomes. BTI is a treatment that prevents or reduces the contraction of the muscles that raise the upper lip. **(Hwang et al., 2009)** and permit the proper healing described by Silberstein**. ( Silberstein et al., 2018)** The effect of BTI remain up to 12 weeks**, (Nasr et al., 2016), (Chagas et al., 2018)**.
This allows for full and homogenous healing, eliminating recurrences or asymmetries as found in other situations **(Bhola et al., 2015).**
Patients with an insufficient width of connected gingiva and significant vertical maxillary excess should avoid lip repositioning surgery. **(Simon et al., 2007).**

The cutting of small salivary glands in the upper lip can result in the development of a mucocele, which is a less common consequence. Other uncommon consequences include paresthesia. (**Miskinyar, 1983**), & transient paralysis. (**Kamer, 1979).**
Because of the difficulty in flap design, suturing, and stability when there is a small band of attached gingiva, lip repositioning surgery is not recommended. (**Rosenblatt & Simon, 2006).**

Aside from the technical problems mentioned above, thin connected gingiva will definitely result in a shallower and narrower vestibule, which may impair the patient's ability to undertake proper oral hygiene. (**Humayun et al. 2010)**

Lip repositioning is a less invasive surgical procedure. Postoperative bruising, soreness, stiffness, and swelling of the upper lip were the most prevalent consequences of lip repositioning surgery documented in the literature. (**Ravon et al., 2008)**.

However, because of the benefits of lasers, few of the participants in our research experienced comparable concerns. When utilizing lasers deep in the tis sues, however, keep in mind the potential for heat damage to the surrounding tissues. The dispersion of laser energy inside surrounding tissues is widely known low, as is the layer of heat_altered tissue that remains after operat ion after vaporization is relatively shallow. (H**aytac & Ozcelik,, 2006**).

Females are more concerned about their smiles and aesthetics than males. Females, on the other hand, were observed to provide greater esthetic scores in reviewing pictures of various GD than males. (**Geron & Atalia, 2005**). Another consequence might be that girls are more likely than males to have GD. Females have a much higher smile prevalence than males, with a frequency of t wice or more in females. (**Peck et al., 1992), (Maulik & Nanda, 2007**)

## 3.5 Conclusions

1. According to the obtained results, diode laser 980 nm can be used effectively at the selected power settings in the surgical management of gummy smile.
2. Excellent hemostasis improves vision with no or minimal bleeding in laser surgery while bleeding is obvious during scalpel surgery.
3. Reduced amount of postoperative pain in laser group that makes it more acceptable to the patients in comparison to the scalpel surgery. It is clear, there is a statistically significant difference in postoperative Edema between a study groups. The swelling is significantly lesser in laser group related to scalped.
4. Patient presenting to treat their gummy smile that is caused by HUL were all satisfied with their smiles after treatment.
5. Lip Repositioning Surgery (LRS) resulted in significant reduction of gingival display on both the anterior sextants and premolar regions & LRS significantly increased the upper lip vermilion length and thickness.
6. The psychological scales of treated patients revealed better quality of life, better self-evaluation of smile esthetics and appearance, and less social appearance anxiety following treatment of gummy smile.
7. These results suggest that the LRS results are stable at 12 months Post Operative (PO).

## 3.6 Suggestions for Future Work

1. Coventional Scalpel surgery can be compared with other types of lasers in performing lip reposition surgery.
2. Diode laser 810 and 980 nm can be compared with other types of lasers in performing lip reposition surgery .
3. Diode laser 810 and 980 nm in continuous and pulsed modes can be compared.
4. Histological study of stages of healing between two techniques can be compared.
5. The number of patients and follow up duration are increased to give more accurate results.
6. lip reposition in combination with crown lengthening procedure can used to obtain better result.
7. Lip reposition in combination with botox injection.

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# APPENDICES

# Patient case sheet

Ministry of higher Education Scientific Research
University of Baghdad
Laser Institution for Postgraduate Studies

Patient Case Sheet
Case No. (  )

**Name:** .....**Age:**.....**Sex:**.....

**Address:**.....**Phone:**.....

**C/C:**.....

**PDH:**.....

**MH:**.....

**No. of Admission:**.....

**Follow up Visits (*Pain, Bleeding, Oedema, Function and Overall satisfaction*)**

**Three days:**.....

**One week:**.....

**Two weeks:**.....

**Four weeks:**.....

| *Scale* | *Pain* | *Bleeding* | *Oedema* | *Function* |
|---|---|---|---|---|
| *No* | 0 | 0 | 0 | 0 |
| *Mild* | 1 | 1 | 1 | 1 |
| *Moderate* | 2 | 2 | 2 | 2 |
| *Severe* | 3 | 3 | 3 | 3 |

| *Scale* | *Poor ( % )* | *Fair ( % )* | *Good ( % )* | *Excellent ( % )* |
|---|---|---|---|---|
| *Overall satisfaction* | 0-25 | 26-50 | 51-75 | 76-100 |

وزارة التعليم العالي والبحث العلمي
جامعة بغداد معهد الليزر
معهد الليزر للدراسات العليا

# معالجة الابتسامة اللثوية باستخدام الليزر

# دايود ٩٨٠ نانوميتر

رسالة مقدمة الى
معهد الليزر للدراسات العليا / جامعة بغداد /لاستكمال متطلبات نيل شهادة
ماجستير علوم في الليزر/ طب الاسنان

من قبل

**هناء صالح عبد المهدي**

بكالوريوس طب وجراحه الفم والاسنان

بأشراف

**الأستاذ الدكتور تحرير نزال الدليمي**

**بورد جراحه الوجه والفكين_ دبلوم عالي تطبيقات الليزر في الطب**

**ماجستير جراحه الفم والوجه والفكين**

٢٠٢١م ١٤٤٣هـ

# الخلاصة

الخلفية: أصبح ليزر الدايود شائعًا في جراحة اللثة نظرًا لامتصاصه جيدًا بواسطة أصباغ الأنسجة مثل الميلانين والهيموجلوبين مع ضعف امتصاص الماء وهيدروكسيباتيت مما يجعله آمنًا للاستخدام حول الأنسجة الصلبة للأسنان.

الهدف: الغرض من هذه الدراسة هو تقييم كفاءة ليزر الصمام الثنائي ٩٨٠ نانومتر في إجراء إعادة وضع الشفة مقارنة بالتقنية الجراحية التقليدية اعتمادًا على الملاحظة السريرية ونتائج المريض.

المواد والطرق: أربعون مريضاً تتراوح أعمارهم بين ١٨ إلى ٣٨ سنة بمتوسط ٢٨ سنة يحتاجون إلى علاج جراحي لتصحيح الابتسامة اللثوية. تم تقسيم المرضى عشوائياً إلى (مجموعتين): مجموعة الدراسة التي عولجت بليزر الصمام الثنائي ٩٨٠ نانومتر والمجموعة الضابطة التي تلقت تغيير موضع الشفاه بالمشرط. تم إعطاء المرضى استبيانًا لتسجيل الألم وعدم الراحة في الأيام الثلاثة الأولى بعد الجراحة ، وأسبوع واحد ، وأسبوعان ، وثلاثة أسابيع ، وأربعة أسابيع بعد الجراحة. تم تقييم الألم وعدم الراحة والنزيف والوذمة والتداخل الوظيفي والرضا العام خلال زيارات المتابعة. تم بدء إعداد معلمات الليزر باستخدام ليزر ديود ، وطول موجي ٩٨٠ نانومتر (QuickLase Dentalase ، المملكة المتحدة) يطبق ٢,٥ واط من الطاقة ووضع الموجة المستمرة (CW) وطرف ٣٠٠ مايكرومتر

النتائج: شارك في هذه الدراسة ستة ذكور وأربع وثلاثون أنثى ، أعمارهم (١٨-٣٨) سنة. كانت هناك اختلافات معنوية في الألم وعدم الراحة والنزيف والوذمة في مجموعة الليزر بالنسبة للمجموعة التي استخدمت المبضع. وجدت الدراسة: لا يوجد دلالة إحصائية في التداخل الوظيفي بعد الجراحة والرضا العام. تم إصلاح مستوى الأهمية عند $P \leq 0.05$.