Sudan University of Science and Technology

Collage of Graduate Studies

Evaluation of Gingival Healing Following Gingivectomy using Diode Laser Versus Scalpel

تقييم إلتئام الأنسجة اللثوية بعد إزالة تورم اللثة باستخدام ليزر اشباه الموصلات مقارنة بالمشرط

A Graduation Project Submitted as Partial Fulfillment for the Requirements of Degree of Higher Diploma in laser in Medicine (Dentistry)

By

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Dedications

*To the souls of my lovely mother and dear father

* To my beautiful family

* To my dear husband

* To everyone helped and supported me.

Badria

2018

Acknowledgments

Great thanks to god.

Thanks to my supervisor Dr. Elhadi Mohieldin Awooda

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Abstract

The aim of this study was to compare the healing of gingival tissues when gingivectomy procedures performed with laser versus scalpel also to evaluate the patient comfort and pain perception.

Eleven patients complaining of gingival overgrowth due to orthodontic treatment participated in the study voluntary. They signed informed written consent to be treated by scalpel gingivectomy in one half of the jaw and other by Diode laser 810 nm with maximum power of 5 W.

Time taken to complete surgery, bleeding, pain and patient satisfaction were assessed to compare by side of laser versus side of scalpel.

Chi-square test was used for inter comparison with level of significant at P value $0< 0.05$.

Sides treated by laser for gingivectomy showed better healing, optimal patient satisfaction and less bleeding.

مستخلص الأطروحة

الهدف من هذه الاطروحه مقارنة التئام الانسجة اللثوية عندما تتم ازالة تورم اللثة بواسطة الليزر مقارنة مع المشرط وتقييم رضي المريض ومعرفة حدة الالم.

احد عشر مريض يعانون من تضخم اللثة نتيجة معالجة تقويم الاسنان شاركو في هذه الدراسة تطوعا بعد التوقيع علي موافقتهم علي المعالجة جراحيا بالمشرط في جهه من الفك والجهه الاخرى بالليزر اشباه الموصلات بقدره 5 وات وطول موجي 810 نانومتر.

تمت دراسة الزمن الذي استغرق لاجراء العملية و النزيف و الالم ورضى المريض وذلك لمقارنة الجهة التي تمت معالجتها بالمشرط مع الجهة الاخرى والتي تمت معالجتها بالليزر. تم استخدام التحليل الاحصائي للمقارنة بين المجموعتين . الجهة التي تمت ازالتها بالليزر اعطت نتيجة التئام جيده و رضي امثل عند المرضى ونزيف اقل.

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Chapter One

Introduction and Literature Review

CHAPTER ONE

Introduction and Literature Review

1.1. Background

In an adult, normal gingiva covers the alveolar bone and tooth root to a level just coronal to the cement-enamel junction (Carranza, 2015) the gingiva is divided anatomically into marginal, attached, and interdental areas. All types are specifically structured to function appropriately against mechanical and microbial damage (Carranza, 2015). Gingival hyperplasia is a common clinical finding and is related to a variety of etiologic factors and pathogenic processes (e.g., dental plaque, mouth breathing, hormonal imbalance and medications.) (Mariotti , 1999)

Gingival soft tissue excisions are routinely carried out in dental practices. These are done to correct irregular gingival contours, remove excess gingival tissue and gingival overgrowths and also to expose the finish lines for restorative purposes. These have been performed either with gingivectomy knives, bard parker blades and electro surgery (Pragathi et al., 2015)

Gingivectomy is a procedure employed to eliminate the pseudo pockets seen in the enlarged gingiva (Ajita et al., 2013). The procedure is employed to remove the diseased tissue, to improve the aesthetics, for prosthetic and orthodontic purposes and to reduce the probing pocket depth of periodontal pockets. Following gingivectomy wound healing is a slow and takes place by secondary intention; it takes a few weeks to establish the normal contour of the gingiva (Ajita et al., 2013). Owing to the slow wound healing several methods such as topical application of medicaments, antibiotics, or amino acids have been tried to improve the healing by secondary intention (Deðim et al., 2002).

Furthermore, techniques that cause lesser tissue damage would allow the wound heal quickly and uneventfully (Buchelt et al., 1994). Laser therapy is a fast growing, simple and a traumatic technique, which has been used in dentistry. The application of laser in animal models and in clinical trials has been reported to stimulate wound repair especially during the first few days of the healing process (Buchelt et al., 1994).

Improved infection control, reduced postoperative pain and sensitivity, reduced patient anxiety and minimizing the need for anesthesia are the other advantages of laser (Pourzarandian et al., 2005). Gingivectomy using lasers may prove to be beneficial to the patient that results in faster healing as compared to the conventional technique (Damante et al., 2004). The first laser assisted interventions performed in periodontology, initiated as early as 1985, have used a laser with CO_2. Now a days, a wide range of lasers for periodontal utilizations are available, such as: Er-YAG, Er, Cr:YSGG, CO_2, Nd:YAG, Diode (Luchiani et al., 2013). Diode lasers introduced by Harris and Pick in 1995, with wavelengths ranging from 810 to 980 nm in a continuous or pulsed mode can be used as possible instrument for soft tissue surgery in the oral cavity (Anuradha et al., 2016). They have been successfully applied in periodontal therapy for soft tissue surgery, haemostasis decontamination, pain therapy or bio-stimulation. They have an in‑depth action, being very well absorbed by haemoglobin (Luchiani et al., 2013)

1.2. Problem statement

Normal wound healing after surgery take long time in which complete epithelial repair take one month and connective tissue about seven weeks, during where many events occur like formation of a protective surface blood clot initially, the underlying tissues become acutely inflamed with necrosis then the blood clot replaced by granulation tissues (Ramfjord et al., 1966) , in 24 hrs there is increase in new connective tissue cells , by the third day fibroblasts are located in the area and the granulation tissues grows coronally then after 24hrs epithelium cells migrate over the granulation tissues(Carranza, 2015). In the inflammatory stage erythema and edema can be seen, during proliferation healthy granulation tissue is granular and uneven in texture it doesn't bleed easily and is red/pink in color. Dark granulation tissue indicates poor infusion or infection. In the maturation phase remodeling of collagen from type III to type I, cellular activity reduces and the number of blood vessels in the wounded area regress and decrease (Hutchinson,1992). Many factors delay healing like infection, diabetes. Now a day's laser is used in surgery to accelerate healing, hemostasis, precise cutting edges, good visibility and less pain.

1.3. Null hypothesis

Gingivectomy performed by Diode Laser does not stimulate healing when compared with conventional gingivectomy by scalpel.

Gingivectomy performed by laser is more painful and not comfortable to the patients than scalpel Gingivectomy .

1.4. Justification

The evidence base for promotion of laser use in dentistry is weak and inconsistent so rigorous studies are needed. The prevalence of laser use in surgery is growing among Sudanese people so more studies are needed to identify its usefulness.

1.5. Objectives

1.5.1. General objectives

To assess the healing of gingival tissues when gingivectomy performed by laser versus scalpel.

1.5.2. Specific objectives

To evaluate the patient comfort and acceptance of laser method.

To evaluate the pain perception according to the visual analog scale in both gingivectomy by laser and scalpel.

1.6. Literature review

1.6.1. Treatment of periodontal diseases

1.6.1.1. Gingiva structure anatomy

Healthy gingiva is normally coral pink with variations in melanin pigmentation among different racial groups. The coronally located gingiva is firm, pink, and is distinguished from the more pliable and redder oral mucosa on the buccal aspect of the maxillary teeth and on the buccal and lingual aspect of the mandibular teeth by mucogingival line or mucogingival junction (Rose et al., 2004.)

1.6.1.2. Gingival diseases

1.6.1.2.1. Dental plaque-induced gingival diseases

- Gingivitis associated with dental plaque only.
- Gingival diseases modified by systemic factors.
- Gingival diseases modified by medications.
- Gingival diseases modified by malnutrition.

1.6.1.2.2. Non-plaque-induced gingival lesions:

- Gingival diseases of specific bacterial origin.
- Gingival diseases of viral origin.
- Gingival diseases of fungal origin.
- Gingival lesions of genetic origin.
- Gingival manifestations of systemic conditions.
- Traumatic lesions.
- Foreign body reactions.
- Not otherwise specified (Armitage , 1999).

1.6.1.3. Gingivitis

Is defined as a non-destructive form of periodontal disease. Inflammation may persist as long as the microbial biofilm is presenting adjacent to the gingival tissues and is reversible (Pihlstrom et al., 2005).

1.6.1.4. Periodontitis

Many definitions of periodontitis have been used in the literature for population-based studies, but there is no accepted standard. In early epidemiologic studies, the two major periodontal diseases, gingivitis and periodontitis, were combined and considered to be a continuum (Roy and Paul 2007).

Periodontitis is a destructive form of periodontal disease, characterized by inflammation and infection of periodontal tissues leading to apical migration of the epithelial attachment and loss of periodontal soft and hard tissues (Albandar and Thomas 2001).

Periodontal disease is a complex, multifactorial, chronic inflammatory disease (Arora et al., 2009).

1.6.1.5. Etiology of periodontitis

1.6.1.5.1. Primary cause

Microbial dental plaque bio-films are the principal etiological factor of periodontitis (Tatakis and Kumar 2005), (Preshaw et al., 2004), (Kinane, 2000).

Dental plaque is the community of microorganisms found on a tooth surface and other surfaces in the oral cavity as a biofilm, embedded in a matrix of polymers of host and bacterial origin (Socransky and Haffajee 2002)(Marsh, 2004). The structure of the plaque biofilm might restrict the penetration of antimicrobial agents (Gilbert et al., 2002) Plaque is natural and contributes to the normal development of the physiology and defenses of the host (Marsh, 2000).

1.6.1.5.2 Secondary cause

Several other local and systemic factors have important modifying roles in its pathogenesis. Etiological and risk factors include age, gender, race, oral hygiene status, socioeconomic status (Susin et al., 2005), psychological factors, drugs (Phenytoin, Cyclosporine and Nifedipine), Alcohol consumption may be associated with increased severity of clinical attachment loss in a dose-dependent fashion. (Tezal et al., 2004) local factors (tooth morphology and alignment, form and location of tooth function, level and quality of dental restorations, dental calculus formation, dental caries lesions near gingival tissue, trauma from occlusion, oral hygiene pattern, alveolar bone morphology, gingival form, and contact between teeth and other local anatomic features), systemic diseases (diabetes mellitus, leukemia) and tobacco usage(Fisher et al., 2005) (Hyman , 2003).

1.6.1.6. Gingival enlargement

Inflammatory gingival enlargement is inflammatory response to local irritant associated with gingiva. The irritant could be microbial deposits (plaque and calculus) fractured tooth, overhanging restorations, ill-fitting prosthesis, orthodontic brackets etc. The presentation begins as slight ballooning of the papilla or marginal gingiva, depending upon the location of the irritant. The bulge may progressively increase in size and extent to become generalized. Clinically gingiva may appear bluish or deep red. It is frequently friable and soft with a smooth shiny surface and they usually bleed easily. Occasionally, chronic inflammatory enlargement may also present as

firm, resilient, pink and fibrotic enlargement which histologically show abundance of fibroblasts and collagen fibers (Agrawal, 2015)

1.6.1.7. Gingivectomy

Surgical removal of excess gingival is often necessary to avoid impaction and displacement of teeth (Hong, 2015).

This procedure can be done conventionally using scalpel or by laser.

1.6.1.7.1. Surgical gingivectomy

The gingivectomy surgical technique has a long history of use in periodontal surgery (Carranza, 2015).

Step 1. The pockets on each surface are explored with a periodontal probe and marked with a pocket marker (Carranza, 2015).

Step 2. Periodontal knives (e.g., Kirkland knives) are used for incisions on the facial and lingual surfaces and on those distal to the terminal tooth in the arch. Orban periodontal knives are used for interdental incisions Bard–Parker blades (nos. 12 and 15) as well as scissors are used as auxiliary instruments. The incision is started apical to the points marking the course of the pockets and it is directed coronally to a point between the base of the pocket and the crest of the bone (Carranza, 2015).

Step 3. Remove the excised pocket wall, clean the area, and closely examine the root surface (Carranza, 2015).

Step 4. Carefully curette the granulation tissue and remove any remaining calculus and necrotic cementum to leave a smooth and clean surface (Carranza, 2015).

Step 5. Cover the area with a surgical pack (Carranza, 2015).

1.6.1.7. 2. Gingivectomy by electrosurgery

Electro surgery permits an adequate contouring of the tissue and controls hemorrhage (Glickman, 1970). Disadvantages it cannot be used in patients who have incompatible or poorly shielded cardiac pacemakers. The treatment causes an unpleasant odor. If the electro surgery point touches the bone, irreparable damage can be inflicted (Glickman, 1970). Furthermore, the heat generated by injudicious use can cause tissue damage and a loss of periodontal support when the electrode is used close to bone. When the electrode touches the root, areas of cementum can be burned (Carranza, 2015). Therefore, the use of electro surgery should be limited to superficial

procedures such as the removal of gingival enlargements, gingivoplasty, the relocation of the frenum and muscle attachments, and the incision of periodontal abscesses and pericoronal flaps. Extreme care should be used to avoid contacting the tooth surface (Carranza, 2015).

1.6.1.7.3. Laser gingivectomy

The lasers that are most often used in dentistry are the carbon dioxide (CO_2) laser and the neodymium: yttrium-aluminum-garnet (Nd:YAG) laser, which have wavelengths of 10,600 nm and 1064 nm, respectively. They are both in the infrared range, so they must be combined with other types of visible lasers for the beam to be seen and aimed. The CO_2 laser has been used for the excision of gingival growths (Carranza, 2015) although healing is delayed as compared with healing after conventional scalpel gingivectomy (Carranza, 2015). The use of a laser for oral surgery requires precautionary measures to avoid reflecting the beam on instrument surfaces, which could result in injury to neighboring tissues and to the eyes of the operator (Carranza, 2015).

1.6.1.7.4. Gingivectomy by chemosurgery

Techniques to remove the gingiva with the use of chemicals such as 5% paraformaldehyde (Carranza, 2015) or potassium hydroxide (Löe, 1961) have been described in the past, but they are not currently used. They are presented to provide a historical perspective. The chemical gingivectomy has the following disadvantages:

• The depth of action cannot be controlled; therefore, healthy attached tissue underlying the pocket may be injured.

• Gingival remodeling cannot be accomplished effectively.

• Epithelialization and reformation of the junctional epithelium and reestablishment of the alveolar crest fiber system occur more slowly in chemically treated gingival wounds than in those produced by a scalpel (Carranza, 2015).

1.6.1.8. Healing after surgical gingivectomy

The initial response after gingivectomy is the formation of a protective surface blood clot. The underlying tissue becomes acutely inflamed with necrosis. The clot is then replaced by granulation tissue (Ramfjord et al., 1966). In 24 hours, there is an increase in new connective tissue cells, which are mainly angioblasts beneath the surface layer of inflammation and necrotic tissue. By the third day, numerous young fibroblasts are located in the area (Ramfjord etal.,1966) .The highly vascular granulation tissue grows coronally and creates a new free gingival margin and sulcus (Carranza, 2015),

Capillaries derived from the blood vessels of the periodontal ligament migrate into the granulation tissue, and, within 2 weeks, they connect with the gingival vessels (Carranza, 2015) after 12 to 24 hours, epithelial cells at the margins of the wound begin to migrate over the granulation tissue, thereby separating it from the contaminated surface layer of the clot. Epithelial activity at the margins reaches a peak after 24 to 36 hours (Carranza, 2015).The new epithelial cells arise from the basal and deeper spinous layers of the epithelial wound edge and migrate over the wound over a fibrin layer that is later resorbed and replaced by a connective tissue bed (Carranza, 2015). the epithelial cells advance by a tumbling action, with the cells becoming fixed to the substrate by hemidesmosomes and a new basement lamina (Carranza, 2015). after 5 to 14 days, surface epithelialization is generally complete. During the first 4 weeks after gingivectomy, keratinization is less than it was before surgery. Complete epithelial repair takes about 1 month (Carranza, 2015).Vasodilation and vascularity begin to decrease after the fourth day of healing, and they appear to be almost normal by the sixteenth day (Carranza, 2015).Complete repair of the connective tissue takes about 7 weeks (Carranza, 2015) the flow of gingival fluid in humans is initially increased after gingivectomy, and it diminishes as healing progresses (Carranza, 2015). Maximal flow is reached after 1 week, which coincides with the time of maximal inflammation.

Although the tissue changes that occur during post gingivectomy healing are the same in all individuals, the time required for complete healing varies considerably, depending on the area of the incised surface and interference from local irritation and infection (Carranza, 2015).

1.6.1.9 Studies in treatment of gingival diseases by different types of laser

In the future the laser may offer an alternative or advancement to current procedures now used in dentistry (Robert et al., 1985).

A study done by Robert M. etal revealed that the advantages of gingivectomy procedures done by the CO_2 laser include lack of hemorrhage yielding a dry field, noncontact surgery, sterilization of the surgical area, prompt healing, minimal post-operative discomfort, and minimal time spent to perform the procedure(Robert et al., 1985).

A pilot study on diode laser treatment yielded very favorable results regarding bacterial reduction of Actinobacillusactinomycetemcomitans, Porphyromonasgingivalis, and Prevotellaintermedia, this long-term study was carried out by Andreas Moritz etal (Andreas et al., 1998) to evaluate the bacterial counts in periodontal pockets irradiated with the diode laser over a 6 month period (Andreas et al., 1998). Changes in periodontal pocket depth and papillary bleeding index were used as significant parameters in the evaluation of the success of treatment (Andreas et al., 1998). Furthermore, lasing is a treatment modality that is finding very good acceptance with patients because it involves minimal pain (Andreas et al., 1998).

Clinical application of lasers to treat periodontal disease is increasing, but remains controversial. Diode lasers have a bactericidal effect due to a localized increase in temperature, which have been verified in vivo using DNA probes that detect periodontal pathogens (Marisa et al., 2013). The diode laser detoxifies root and implant surfaces by inactivating bacterial endotoxins. It is hemostatic and produces no smear layer. The thermal effect weakens calculus chemical adhesion to the root and/or implant, facilitating its removal by curette or ultrasonic devices (Marisa et al., 2013). The diode laser also stimulates fibroblasts and osteoblasts which in turn, cause increased production of RNA messengers, leading to significant collagen production during periodontal tissue healing (Marisa et al., 2013). The patient experienced no postoperative discomfort and he was able to comply with home care procedures, such as debridement, after the surgery (Marisa et al., 2013). In contrast, patients often have post-treatment discomfort, and compliance with home care procedures decreases because the recommended home care protocols for plaque control are painful; this results in impaired healing (Marisa et al., 2013). Important changes were also detected in the patient: Bleeding, a marker of inflammation with a high prognostic value, was compared at baseline and at 1 year after laser-assisted periodontal therapy, and was reduced significantly (Marisa et al., 2013)

Various studies have demonstrated the benefits of diode laser in various oral soft tissue procedures. Precise cutting abilities, good coagulation effect and the extremely small zone of thermal necrosis to surrounding tissues are the advantages of using laser (Praveen et al., 2015).

Chapter Two

Basic Concepts of Laser

CHAPTER TWO

Basic Concepts of Laser

2.1. Laser

The word Laser is acronym for Light Amplification by Stimulated Emmition of Radiation (William, 2004).

2.2. Development of laser

Professor Albert Einstein (Einstein, 1917) published all of the necessary formulas and theoretical concepts to build a laser in his 1917 treatise. In this treatise, he described the interaction of atoms and molecules with electromagnetic energy in terms of the spontaneous absorption and emission of energy. Then, in 1960, the first true laser, a ruby laser, was operated by Dr. Theodore H. Maiman (Maiman, 1960). The development of additional lasers occurred rapidly, with the helium-neon laser appearing in 1961, the argon laser in 1962. In 1963 Dr. Leon Goldman, a dermatologist at the University of Cincinnati, first employed a ruby laser for the removal of tattoos and other pigmented cutaneous lesions (Goldman et al., 1963). The carbon dioxide and nd:yag laser are developed in 1964, the dye laser in 1966, the excimer laser in 1975, the copper vapor laser in 1981 and the gold vapor laser in 1982. Since those earliest days, many physicians in different specialties have played key roles in the advancement of the use of lasers in medicine (Wheeland, 1995).

2.3. Properties of laser

The most characteristic properties of laser beams include monochromaticity, single wavelength, coherence (spatial and temporal), directionality and brightness. (Orazio , 1998).

2.4. Elements of laser

All lasers are composed of the same four primary components. These include the power supply or “pump” that excites the atoms and creates population inversion, this

can be accomplished by direct electrical current, optical stimulation by another laser (such as argon), radiofrequency excitation, white light from a flash lamp or chemical reactions.

The laser medium (usually a solid, liquid or gas).

The optical cavity or resonator which surrounds the laser medium and contains the amplification process.

A delivery system (usually a fiber optic or articulating arm with mirrored joints) to precisely deliver the light to the target (Peng et al., 2008).

2.5. Spontaneous emission

Characterized by the emission of a photon of energy when the atom decays from higher level to lower level.

$$V_0 = \frac{(E_2 - E_1)}{h}, \qquad 2.1$$

where h is Planck's constant. (Orazio , 1998).

The decay can also occur in a non-radioactive way. In this case the energy difference $E_2 - E_1$ may go into kinetic or internal energy of the surrounding atoms or molecules. This phenomenon is called non-radiative decay (Orazio, 1998).

2.6. Stimulated emission

Is process by which an incoming photon of a specific frequency can interact with an excited atomic electron or other exited molecular state causing it to drop to a lower energy level, the liberated energy transfers to the electromagnetic field creating a new photon with a phase, frequency, polarization and direction of travel that are all identical to the photon of the incident wave (Orazio, 1998).

2.7. Laser types

According to the physical state of the active material lasers can be classified into solid state, liquid or gas. The solid lasers are represented by the ruby, neo- dymium:yttrium-aluminum-garnet (Nd:YAG), alexandrite, erbium, and diode lasers. Gas lasers are argon, excimers, copper vapor, helium-neon, krypton and carbon dioxide lasers (Orazio, 1998). The most common liquid lasers contain a fluid with dye. rhodamine . Also it is classified based on the length of activity of the beam into continuous, pulsed and ultra-short pulsed, moreover, laser can be classified according to the wavelength of the emitted radiation into infrared, visible, UV and X-ray lasers. (Orazio , 1998).

2.8. Laser applications

Most of laser devices are used clinically to treat a wide variety of conditions and disorders. This based on lasers wavelength, nature of their pulse and energy**.**

2.9. Medical applications of lasers

Lasers have potential applications in medical fields in diagnosis and therapy processes.

In diagnosis as in angioplasty cancer diagnosis, laser mammography, medical imaging, microscopy optical coherence tomography and optogenetics.

In therapy as in ophthalmology (includes Lasik and laser photocoagulation) prostatectomy, plastic surgery, in laser liposuction, surgery to ablate and cauterize tissue, cancer treatment, cosmetic dermatology such as scar revision, skin resurfacing, laser hair removal, tattoo removal dermatology to treat melanoma, frenectomy, gingivectomy and lithotripsy (Ping et al., 2008).

2.10. Absorption

Absorption depends on concentration and absorption spectra of specific molecules in the tissues. It is highly dependent on the wavelength. Ultraviolet wavelength are highly absorbed by proteins, visible wavelength can identify specific features of absorption by hemoglobin, melanin and other pigments. At 700-900nm the absorption is low so maximum penetration of light in tissue occur "Optical window". In infrared wavelengths absorption is mainly due to water, highest at 2.95 microns (Ping et al., 2008).

2.11. Laser tissue interaction

In order for laser to affect tissue, absorption must take place (Ping et al .,2008). The rate of energy absorption determines whether photochemical, thermal or photomechanical effects are dominant.

2.11.1. Thermal

The initial deposition of energy depends on the tissue optical properties and the irradiation condition (Ping et al., 2008). If the light is delivered in a short pulse, the local temperature will increase rapidly because heat diffusion is minimized. This is referred to as thermal coefficient. Blood flow can also have a major influence on the time course of temperature (Ping et al., 2008).

2.11.2. Photochemical

In the case of photochemical, initial absorption occurs by specific molecules. If the energy of the photon is high enough then direct bonds breaking of molecules is possible. The molecule can be raised to an exited state from which a variety of chemical reactions are possible such as the generation of free radicals and reactive oxygen species (Ping et al., 2008).

2.11.3. Photomechanical

For very high rates of energy deposition, shock waves can be generated in the tissue by mechanisms such as bubble expansion/collapse or plasma formation. The mechanical properties of the tissue govern the propagation of these waves and their biological effect. Tissue can be ablated, torn or shattered (Ping et al., 2008).

Chapter Three

Materials and Methods

CHAPTER THREE

Materials and Methods

3.1. Materials

11 subjects with an age range from 12 years and above had participated in this study they were all systemically healthy and they were diagnosed as having gingival enlargement. On one side of their jaws gingivectomy was done using the Diode laser. The other side was treated using scalpel to perform non laser gingivectomy. The surgeries were performed at Molar center for laser procedures and Khartoum teaching hospital for scalpel procedures. All surgeries were done after explaining to the patient the aim of this study and informed consent was taken.

3.1.1 Study design

The study was clinical with split mouth design.

3.1.2 Study population

Patients attended orthodontic department suffering from gingival overgrowth and indicated for gingivectomy.

3.1.3. Inclusion criteria

Patients of age of 12 years and above, having bilaterally symmetrical gingival hyperplasia.

3.1.4. Exclusion criteria

- Patients with debilitating diseases.

- Patients under any systemic treatment.

- Patients with local inflammatory conditions.

3.1.5. Sample size and technique

11 patients selected by non-probability purposefully technique.

3.1.6. Equipment's and tools

- The diode laser (elexxion) class 4, made in Germany with a wavelength of 808 nm, maximum power 5W and 230V/50Hz/60Hz power supply.

3.2. Method

A standard oral hygiene regimen was done for all the patients to remove any irritant factors prior to surgery and chlorhexidine mouth wash for oral rinse twice daily was described to maintain oral hygiene.

3.2.1. Non laser treatment

Local infiltrations of the tissue, scalpel technique was done to treat one side of the jaw (split) using scalpel blade no. 15c. The side treated surgically was considered as surgical group

3.2.2. Laser treatment

On the other half the gingival overgrowth was excised with diode laser (elexxion), with a wavelength of 808 nm and fiber diameter of 400 micrometer in pulsed contact mode, pulse interval and length 26ms. Power setting was adjusted according to the ease of use but on an average of 2W was used.

Figure 1. Diode laser (elexxion)

The surgical procedures were performed under local anesthesia. The side treated with diode laser was considered as laser group.

Postoperatively, for all procedures analgesics were prescribed when required in the form of Ibuprofen 400mg and a chlorhexidine mouth wash for oral rinse twice daily to maintain oral hygiene. The patients were advised to have soft diet on the day of procedure.

3.2.3. Parameters

Intra-operative and post-operative parameters were assessed (Praveen et al., 2015) using a chick list for every patient (Appendix II).

- Intra-operative:

Evaluation of haemostasis, tissue sticking to the instrument and time taken to complete the procedure. Intraoperative bleeding was graded as: None: 1, Self-limiting:2, Requiring light pressure: 3, Requiring coagulation: 4.Tissue sticking to the instrument during the procedure was graded as: None: 1, Requiring activation of the instrument to release tissue: 2, Requiring gentle grasping and removal of tissue from the instrument: 3, Requiring extensive force for removal of tissue from the instrument: 4, Tearing tissue when instrument tip released from application site: 5 (Praveen et al., 2015).

- Postoperative:
- Satisfaction, pain and healing.

Patients were asked if they were very satisfied, satisfied, moderately satisfied, neutral or unsatisfied.

- Evaluation of pain:

Post-operative pain was evaluated after laser and non-laser treatment, 3 hours, 72 hours and 1 week (Praveen et al., 2015)

Patient was asked to monitor the pain response. Pain questionnaire

according to visual analogue scale (VAS) (a testing technique for measuring subjective or behavioral phenomena as pain or dietary consumption in which a subject selects from a gradient of alternatives as from no pain to worst imaginable pain arranged in linear fashion from 0 to 100 points).

Figure 2. Visual analogue scale

- Using this scale six degrees of pain were described: code 0 - no pain, code 1 - slight discomfort to bearable pain (0-10 points), code 2- mild pain (20-40 point), code 3- moderate pain (40-60), code 4- severe pain (60-80), code 5- intolerable pain (80-100).

- Evaluation of healing

- The surgical sites were evaluated for the followings: Tissue color (red, pink or bluish); tissue contour (normal, hyperplastic, or atrophic); and clinical status of the healing wound for the specific time interval (normal, better than normal, worse than normal). For the purpose of analysis, a three point's scale was used to score the healing of the surgical wounds: Score 1: Indicating superior healing of laser-treated wounds compared to non-laser treated sites. Score 0: Indicating that laser-treated sites and control sites exhibited the same degree of healing response. Score 2: Indicating that control exhibited superior healing when compared to laser-treated test sites (Praveen et al. 2015). Blindly two periodontists were asked to evaluate healing.

- Ethical Approval:-

  Study was approved by Ethical Committee Institute of laser Sudan University of Science and technology. Patients were requested to participate voluntary after explaining the purpose of the study.

  Those who accepted to be treated by both laser and scalpel surgeries informed written consent. Data were kept confidential as only used for the purpose of the study.

All statistical procedures performed using SPSS 23.0 Statistical Software Program (SPSS,Inc.,USA).

- Using Chi Square test to Compare between (Healing) for both groups.
- Using significant level 0.05.

Data were analyzed with the help of statistician.

Chapter Four

Results and Discussion

CHAPTER FOUR

Results discussion Conclusion and Recommendations

4.1 Results and discussion

In this study a total of eleven patients with bilaterally symmetrical gingival hyperplasia from orthodontic clinics of khartoum teaching hospital and military hospital were selected. The age range was 12 and above. The aim of this study was to compare the healing process, patient comfort and evaluate the pain perception according to the visual analog scale when gingivectomy performed by laser versus scalpel. Diode laser are optimal for gingival surgery due to their ability to be absorbed by gingival tissue and not by the adjacent structures (Goharkhay and Moritz 1999). The interaction of laser wavelength and energy density with tissues at the tip of fibreoptic contact delivery system allows simultaneous cutting and coagulation of tissue (Goharkhay and Moritz 1999). For this study split mouth design was chosen because it minimizes the influence of numerous inter-subject factors, such as age, sex, anatomic factors, and bone metabolism, or any differences that may be present (Lobo, 2015). Sample size requirement of split mouth design are much less as compared to other methods (Praveen et al., 2015).

4.1.1 Haemostasis

On laser side, there was no bleeding in 6 patients (54.5%) and the bleeding was self-limiting in 5 patients (45.5%). On scalpel side bleeding was self-limiting in 4 patients (36.4%) and requiring light pressure in 7 patients (63.6%). Bleeding during laser surgery was less than scalpel agrees with the study done by Ajita Meenawat etal (Ajita et al., 2013) that clinical observation demonstrates less blood when resecting gingiva with a laser due to coagulation properties also agree with Praveen Kumar etal (Praveen et al., 2015) that good coagulation effect occur with diode laser. Agree with Samia Aboujaoude etal (Samia et al., 2016) and Marisa Roncati1 (Marisa et al., 2013) that the diode laser enhanced the visibility due to its hemostatic properties.

4.1.2. Tissue sticking

On laser side during the procedure, there was no tissue sticking in 3patients (27.3%) and in 8 patients (72.7%) removal of tissue required gentle grasping from the tip of the instrument. There was sticking of tissue to the tips on the laser side during application and in majority of patients gentle grasping was required to remove the tissues. Tissue sticking was more on the laser side where the overgrown tissue was deep or thick and in those cases tip of the fibre required cutting and removal of sheath. This agrees with the study done by Praveen Kumar et al (Praveen et al., 2015). We concluded that for bulky and deep gingival overgrowth, laser is an inappropriate tool for excision (Praveen et al., 2015).

4.1.3. Duration of surgery

The procedures done with laser took less time than procedures done with scalpel (**Table**1), (**Table**2) this agree with study done by Robert M. Pick et al (Robert et al.,1985).

Table 1. The distribution of duration of the laser Group.

Duration of surgery	Frequency	Percent
more than 1/4 hour	2	18.2%
1/4 hour	8	72.7%
less than1/4 hour	1	9.1%
Total	11	100.0%

Table 2. The distribution of duration of the non-laser group

Duration of surgery	Frequency	Percent
1/2 hour	4	36.4%
more than 1/4 hour	1	9.1%
1/4 hour	5	45.5%
less than1/4 hour	1	9.1%
Total	11	100.0%

4.1.4. Patient satisfaction

Optimal patient satisfaction was found with laser surgery this agree with Ajita Meenawat etal mentioned that laser treatments is a unique noninvasive procedure and have minimal patient discomfort (Ajita et al., 2013) and agree with Andreas Moritz etal found that diode has very good acceptance with patients because it involves minimal pain(Andreas et al.,1998).

Table 3. The distribution of satisfaction of the laser group.

Patient satisfaction	Frequency	Percent
Very Satisfied	6	54.5%
Satisfied	2	18.2%
Natural	1	9.1%
Unsatisfied	2	18.2%
Total	11	100.0%

Table 4. The distribution of satisfaction of the non-laser group.

Patient satisfaction	Frequency	Percent
Very Satisfied	2	18.2%
Satisfied	5	45.5%
Natural	4	36.4%
Total	11	100.0%

4.1.5. Pain

Regarding postoperative pain score was slightly more on the side treated with non-laser as compared to diode laser side3 Hours after procedures but the difference between the two groups was statistically insignificant with *p value* of 0.193 (Table 5),then after no pain was recorded in laser or non-laser group this agree with Hadeel etal (Hadeel et al., 2017) . In Laser gingivectomy they found that the pain post-operatively was less compared to the pain in non-laser gingivectomy this could be attributed to the heat generated by laser that inhibit the pain receptors9 and the coagulation which provided a dry and isolated environment and less infection to the wound(Hadeel et al., 2017). Also agree with Ajita Meenawat etal (Ajita et al., 2013) of lack of pain and Andreas Moritz etal (Andreas et al.,1998) of minimal pain.

Table 5. Intergroup Comparison between VAS for Laser group and VAS for non-laser group after 3 hours

Method	No pain	Moderate	*P Value*
Non-laser	5	6	
	45.5%	54.5%	
Laser	8	3	0.193
	72.7%	27.3%	

4.1.6. Healing

The present study showed that there was no statistically significant difference in the healing following gingivectomy after 3 days. The *p value* was (0.077) (Table.6), but the post- operative outcome regarding healing with laser versus scalpel at 3 days showed pink color of the tissues in laser side in most of the cases which indicate better healing. Regarding appearance of wound, fibrinous slough was present on both sides, charring was not observed on laser side.

Table.6. Intergroup comparison between healing for laser group and non-laser group.

Healing	3 Days	1 Week	3 Week
Equivalent	2 18.2%	7 63.6%	9 72.7%
Better on laser side	8 72.7%	3 27.3%	2 18.2%
Inferior on laser side	1 9.1%	1 9.1%	0 0%
P-Value	0.077	0.77	0.77

P value for healing is (0.077)

Minor differences indicate good but delayed healing on laser group were found which are not statistically significant after 1week and 3 weeks, well adapted tissues, good contour of the gingiva and pink color was observed this agree with the study done by Ajita et al., 2013) who observed that diode laser provides precise incision margins , lack of swelling or scar tissue formation and eventually good wound healing after histological analysis (Ajita et al., 2013), supporting that In the follow-up biopsy 7 days it was observed that scalpel wounds had dense inflammatory infiltrate and moderate amount of fibers, whereas laser treated site had fewer inflammatory cells and densely fibers tissue (Ajita et al., 2013). This observation can be correlated to the fact that laser treatment causes destruction of epithelial and stromal cells but leaves much of the connective tissue matrix intact and the basement membrane resists laser irradiation (Ajita et al., 2013).The laser-induced wounds heal through reparative synthesis of matrix proteins (Ajita et al., 2013). The relative resistance of matrix proteins against laser irradiation and the slow removal and replacement of the residual matrix accounts for the lack of scarring and contraction observed in laser-treated areas(Ajita et al., 2013], agree with Hadeel etal (Hadeel et al., 2017) found that histologically, in the biopsy taken after 7 days less infiltration of inflammatory cells had been seen in laser with a good improved epithelization, which result in reducing the scars and the contraction of the wound and thus improve the healing (Hadeel et al., 2017) .

4.2 Conclusion

Diode laser is optimal for gingival surgery due to their ability to be absorbed by gingival tissue and not by the adjacent structures. Little local anesthesia was required with laser, good visualization during procedures due to bloodless field and less time was required, less pain and more satisfaction for the patients. End results of healing were better in laser group and good contour.

4.3 Recommendations

From the results of this study we recommend the following:

Further studies with adequate sample sizes are required.

Histological evaluation of gingival healing is required.

A study to evaluate bio stimulation effects of laser in combination with laser gingivectomy is recommended.

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Photos

Figure .3. Pre-operative (gingival enlargment right upper side of the jaw)

Figure 4. Pre-operative (gingival enlargment left upper side of the jaw)

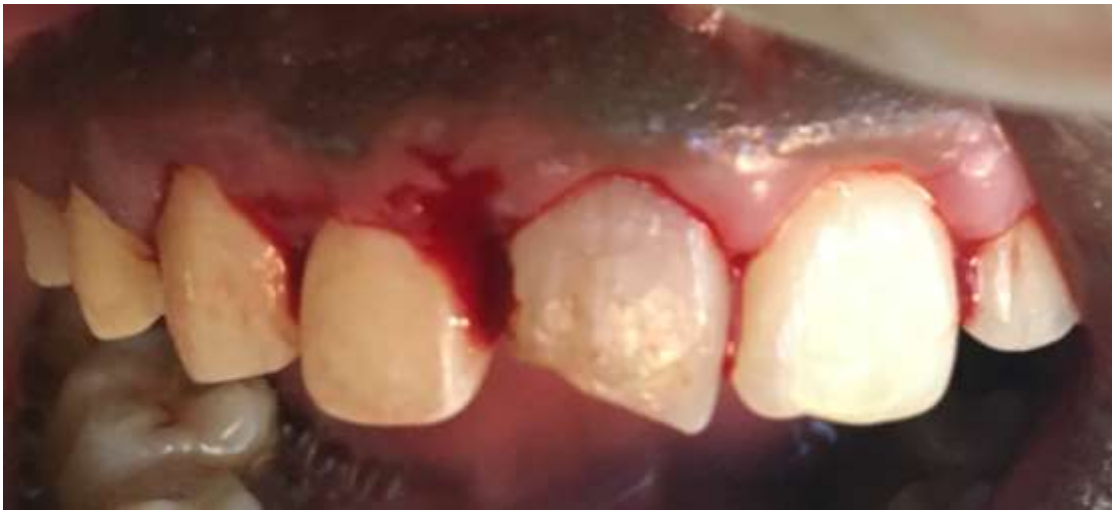


Figure 5. Day of scalpel surgery(right upper side of the jaw) bleeding is obvious.

Figure 6. Day of laser surgery(left upper side of the jaw) no bleeding.

Figure 7. fifth day upper jaw (laser surgery left side of the jaw scalpel right side**)**

Figure 8. After2 weeks (laser surgery left side of the maxilla scalpel right side**)**

Figure 9. After 3 weeks (laser surgery left side of the maxilla scalpel right side**)**

Figure 10. Pre-operative (gingival enlargment lower jaw)

Figure 11. Day of laser surgery(lower jaw no bleeding)

Figure 12. fifth day lower jaw (laser surgery left side of the jaw scalpel right side**)**

Figure 13. After2 weeks (laser surgery left side of the mandible scalpel right side**)**

Figure 14. After 3 weeks (laser surgery left side of the mandible scalpel right side**)** well adapted tissues and good contour on the laser side.

Appendix (I)

جامعة السودان للعلوم والتكنلوجيا

معهد الليزر

استمارة موافقة للمشاركة في البحث

يقيم معهد الليزر بحثا لمقارنة معالجة تورم اللثة باستخدام الليزر والمشرط وذلك من خلال اجراء عمليات جراحية بالطريقتين. بناء علي ما تم ذكره اقر بموافقتي الشخصية كمتطوع في البحث المعني علي ان لا تستخدم النتايج لغير أهداف البحث.

اسم المشترك:.....

الرقم:.....

اقر انا المذكور اعلاه بموافقتي علي الاشتراك في البحث كمتطوع علما بانه تم شرح اهداف هذا البحث لي.

التوقيع:.....

Appendix (II)

Evaluation of Gingival Healing Following Gingivectomy Using Diode Laser Versus Scalpel

According to the study puplished 2015 Jun by Praveen Kumar etal. Comparative evaluation of healing after gingivectomy with electrocautery
and laser.

The chick list

Personal data:

Name: Telephone Number:

Age: Marital status:

Sex: Occupation:

Address: Ethnic group:

Clinical examination:

The degree of gingival enlargement was scored as follow:

Grade 0= no signs of gingival enlargement

Grade I= enlargement confined to interdental papilla

Grade II= enlargement involved papilla and marginal gingiva

Grade III= enlargement covered three quarters or more of the crown

Clinical Assessment:

Intraoperative:

Bleeding:

1=None. 2= Self-limiting.

3=Requiring light pressure. 4= Requiring coagulation.

Tissue sticking to the instrument:

1=None.

2=Requiring activation of the instrument to release tissue.

3= Requiring gentle grasping and removal of tissue from the instrument.

4= Requiring extensive force for removal of tissue from the instrument.

5=Tearing tissue when instrument tip released from application site.

Time taken to complete the procedure (Duration):

1. 1/2 an hour.
2. More than 1/4 an hour.
3. 1/4 an hour.
4. Less than 1/4 an hour.

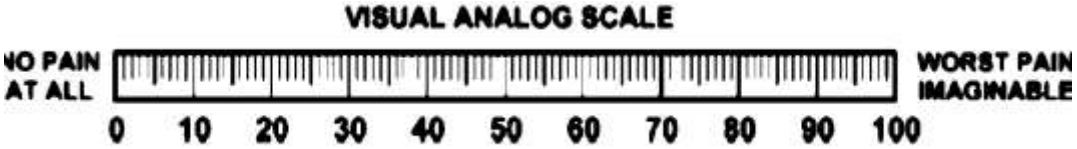
Patient satisfaction:

1. V. Satisfied.
2. Satisfied.
3. Moderately satisfied.
4. Neutral.
5. Unsatisfied.

Method	bleeding	Tissue sticking to the instrument	Duration	Patient satisfaction
Laser				
Scalpel				

Post-operative:

Pain perception (visual analog scale, VAS):



Using this scale six degrees of pain can be described: code 0 - no pain, code 1 - slight discomfort to bearable pain (0-10 points), code 2- mild pain (20-40 point), code 3-

(60-80), code 5- moderate pain (40-60), code 4- severe pain intolerable pain (80-100).

0= no pain

1= slight discomfort to bearable pain 0.1-1 cm (1-10mm)

2= mild pain 2-4 cm (20-40mm)

3= moderate pain 4.1-6 cm (40.1-60 mm)

4= severe pain 6.1-8 cm (60.1-80 mm)

5= intolerable pain 8.1-10 cm (80.1-100mm)

	Time (period) for pain		
Method	3 hours	3 days	1week
Scalpel	0	0	0
Laser	0	0	0

Tissue color:

a= Red.

b= pink.

c= bluish.

d= purple

e= charred.

Tissue contour:

I=normal

II= hyperplastic

III= atrophic

Appearance of wound:

1. Granulated.

2. Slough.

3. Necrotic.

Re-epithelialization:

A. complete epithelialization

B. incomplete epithelialization

C. ulcer

D. tissue defect or necrosis

	Tissue color	tissue contour	Appearance of wound	Re-epithelialization
3 days				
Laser				
Scalpel				
1 week				
Laser				
Scalpel				
3weeks				
Laser				
Scalpel				

Healing:

0= laser-treated sites and Scalpel sites exhibited the same degree of healing response .

1= Superior healing of laser- treated wounds.

2= Scalpel exhibited superior healing when compared to laser-treated sites.

Method	3 days	1 week	3 weeks
Laser			
Scalpel			