REPUBLIC OF TURKEY
GAZI UNIVERSITY
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ORAL AND MAXILLOFACIAL SURGERY DEPARTMENT

ASSESSMENT OF HARD TISSUE DENSITY AROUND DENTAL IMPLANTS USING CONVENTIONAL RADIOGRAPHS

DOCTORAL THESIS

Dt. Wael AL-SHAIBANI

Supervisor
Prof.Dr. Nur MOLLAOĞLU

ANKARA
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T.C.
GAZİ ÜNİVERSİTESİ
Sağlık Bilimleri Enstitüsü

Ağız, Diş, Çene Hastalıkları ve Cerrahisi Ana Bilim Dalı Doktora Programı çerçevesinde yürütülmüş olan bu çalışma aşağıdaki jüri tarafından Doktora Tezi olarak kabul edilmiştir.

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I would like to dedicate my thesis to my respectful father

ISMAIL AL-SHAIBANI.

APENDIX

PICTURES

FIGURES

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SYMBOLS

CPTi	Commercially pure titanium implants
CP	Commercially pure
OI	Osseointegration
PA	Periapical
PN	Panoramic
LLLI	Low level laser irradiation
LLLT	Low level laser therapy
LLL	Low level laser
ATP	Thriphosphate
ALP	Alkaline phosphatase
HE-Ne	Helium neon
GaAlAS	Gallium aluminum arsenide
GaAs	Gallium arsenide
UTS	Ultimate tensile strength
YS	Yield strength
BIC	Bone-implant contact
PTi	Pure titanium implant
µm	Micrometer
CT	Computed tomography
W	Watt
J	Joule
AR	Argon
CO	Carbon dioxide
nm	Nanometer
F	Flap
MF	Mini-flap
L	Laser
NL	Non-laser
Nd:YAG	Neodiyum-Yitrium-Aluminum-Okside-Garnet

Er:YAG	Ebrium-doped:Yttrium-Aluminum-Garnet
CHA	Calciumhydroxyapatite
RVG	Radiovisiographi

1. INTRODUCTION AND AIMS

Today the aim of dentistry is to provide normal contour, function, comfort, esthetic, speech, and health, regardless of the atrophy, oral diseases, or injury of the oral cavity[1]. However, more teeth a patient is missing, more challenging the goal becomes with current dental treatment methods. Latest researches demonstrated that advanced implant designs, materials, and techniques can lead to more successful results in their application, and several different types of implants are now available to solve different clinical problems[2]. Dental implant is a device of biocompatible material placed within or against the mandibular or maxillary bone to provide additional or enhanced support for the alveolar crest or prosthesis. Nowadays, various implant configurations are usually available within each system. Implant configuration is a specific shape or size of implant to accommodate the anatomic variations of available bone that commonly observed in patients[3].

P.I. Brånemark who is a Swedish orthopedic surgeon led to the discovery of commercially pure titanium implants (CPTi). When these implants placed in a suitably prepared site in the bone, it could become fixed in place due to a close bond that developed between alveolar bone and dental implant which has been described later on as osseointegration[4,5](OI). OI is the direct structural and functional connection between living bone and the surface of a load-bearing dental implant[3]. There has been demographic evidence that implants are becoming a major service of dentistry since 1990s[6].

Implant success is generally evaluated on the basis of clinical findings such as the severity of peri-implantitis, bleeding on probing, pocket depth, and implant mobility[7-9]. In addition, radiologic follow-up examinations can provide evidence of changes around peri-implant bone structures by time. To monitor marginal bone loss, conventional imaging techniques such as periapical (PA) dental radiographs and panoramic (PN) radiographs have been recommended postoperatively[6].

Lasers have been used for many years in oral surgery and implant dentistry. In some cases, laser treatment has become state of the art compared to conventional techniques[10]. In hard tissues, low level laser irradiation (LLLI) was reported to speed up vascularization and to increase the number of trabeculae in fractured bone sites[11]. However, the mechanism how laser irradiation can promote bone formation has not fully understood yet. The most probable hypothesis is that the laser energy excites the prophirines and the cytochromes and, in this way, promotes an increase in cellular activity, increasing the concentration of adenosine tri phosphate (ATP), alkaline phosphatase (ALP), and liberating calcium[12]. It is reported that low level laser therapy (LLLT) does improve bone matrix production due to improved vascularization and anti-inflammatory effects[12]. There are many different types of lasers to be used in LLLT such as pulsed or continuous and having wavelengths in the visible and invisible range. Moreover, a number of different lasers light, including helium-neon (He-Ne), gallium aluminum arsenide (GaAlAs), argon and others have been used in different doses and treatment schedules. The GaAlAs diode laser is known to be a high tissue-penetration laser because hemoglobin and water have a low coefficient of absorption[12]. Furthermore, mineral analysis suggests that calcium and phosphorus contents on the implant surface can also increase when the implants are irradiated with LLL which helps OI[13].

Dental implant surgery starts with raising flap procedures for implant insertion. The surgical flap design to expose the implant site should be based on certain factors, including the need for adequate exposure of the surgical site, but not at the expense of excessive stripping of the periosteum and compromise of the blood supply necessary for implant and surgical wound healing. The flap design should also allow for primary closure without tension on the flap. Such tension generally leads to flap's opening and exposing the implant and the surgical site, increasing the risk of poor or delayed wound healing and surgical site infection. The flap design should aid in achieving circumferential adaptation of good quality tissues around emerging implant structures[14,15].

An acceptable clinical examination and appropriate radiographic examination are mandatory prior to every implant surgery[16]. Radiologic follow-up examinations can provide evidence of changes of a peri-implant bone over time. To monitor marginal bone loss, conventional imaging techniques such as PA dental films and PN radiographs have been recommended postoperatively[6,17,18,19,20,21]. Consequently, rectangular imaging techniques with symmetric distortion (isometric magnification) have been advocated for the evaluation of peri-implant bone loss[6,16,22].

Therefore the aim of this study is to compare the effects of flap and mini-flap implant surgeries around dental implants and also investigate the effect of LLLT with GaAlAs diode laser device on implant healing and attachment using Scion Image Real Convertor programme 5.5 to analyze the level of bone loss around dental implants on digital PN and PA radiographs.

2. GENERAL INFORMATION

The absence of teeth in the dental arch is due to either congenitally or as a result of disease because of caries and periodontal breakdown as they are the most common. Missing tooth should always be replaced, when it is desirable to improve appearance, masticatory function or speech, or sometimes to prevent harmful changes in the dental arches, such as the over eruption or tilting/drifting of teeth[1,2,4]. The increased need for implant replacement is usually due to the combined effect of a number of factors, including[2]:

(A) Age-related loss of teeth,

(B) Anatomic conditions of edentulous ridges,

(C) Psychological needs of the patient,

(D) Decreased performance of removable prostheses,

(E) Predictable long-term results of implant-supported prostheses,

(F) Increased awareness of the benefits of implants by the profession and the public.

Over the past 30 years, the use of osseointegrated implants has become a scientifically accepted and well-documented treatment modality for the rehabilitation of completely and partially edentulous patients[23-29]. A sufficient quantity of bone is required for the installation of oral implants and their successful long-term prognosis. However, severe resorption of the alveolar ridge in vertical and/or horizontal dimensions after tooth loss often occurs, thus jeopardizing the subsequent placement of oral implants. Several factors such as the primary stability of the implant, the morphology of the bony bed, control of infection and an adequate healing period without loading are critical for the long-term success of dental implants[23]. Successful dental implant requires that OI be achieved and cervical bone height is maintained[24].

OI has become a common term in the dental community because of the widespread use of implants. It is the morphologic and functional coexistence between bone and surface of a load-carrying implant. The process of OI in many ways stimulates new bone formation that occurs naturally and during healing of the osteotomy defect[14].

LLLT has enhanced the treatment of a variety of morbid states including alleviating pain, healing wounds, and resolving nerve injuries. Recent reports have reported that LLLT could also stimulate osseteogenesis during bone remodeling and positively influences osseteogenesis in the surrounding tissue and OI[25,26].

2.1. Dental Implants

Dental implant treatment has recently become popular for the oral rehabilitation, replacing conventional dental treatments[27-31]. Implants are placed most commonly in the partially or fully edentulous mandible or maxilla. They are classified according to their position, their constituent material and their morphological design[14].

Position of Dental Implants: Classified whether endosseous, subperiosteal, or transosseus, depend on the stability of supporting bone[14]:

. Endosseous implants: Endosseous implants comprise one broad category of implants. They can be divided as root forms, plate/blade forms, and endodontic stabilizers;

A- Root Forms: Root form implants are designed to resemble the shape of a natural tooth root. They are usually in circular cross section. Root forms can be threaded, smooth, stepped, parallel sided or tapered, with or without a coating, with or without grooves or a vent, and can be joined to a wide variety of components for retention of prosthesis.

B- Plate/Blade Forms: As its name suggests, the basic shape of the plate/blade form implant is similar to that of a metal plate or blade in cross-section. Some plate/blade forms have a combination of parallel and tapered sides. Screws and cylinders are both root form modality; plate and blade forms are both the plate/blade form modality.

C- Endodontic Stabilizer Implants: Although endodontic stabilizer implants are endosteal implants, they differ from other endosteal implants in terms of functional application. Rather than providing additional abutment support for restorative dentistry, they are used to extend the functional length of an existing tooth root to improve its prognosis and to support bridgework when required. Modern endodontic stabilizers take the form of a long, threaded post that passes at least 5 mm beyond the apex of the tooth root into available bone.

. Subperiosteal Implants: The subperiosteal implant modality is distinct from the endosteal implant modalities in that the implant is placed under the periosteum and against bone on the day of insertion, rather than within alveolar bone. This modality is used in cases of advanced alveolar resorption, in which the volume of the residual available bone is insufficient for the insertion of an endosteal implant.

. Transosteal Implants: Transosteal implants are the most surgically invasive and technique-sensitive. They are limited to the mandible. Although transosteal implants have proven safety and efficacy, they are not considered mainstream because of their complexity and the demands they make on both the practitioner and the patient. Transosteal implants feature a plate that is placed against the exposed inferior border of the mandible, with extensions that pass from this plate through the symphyseal area, out of the crest of the ridge, and into the oral cavity.

Materials of Dental Implants: Many materials have been used for implants, including ceramics such as aluminum oxide and metals ranging from alloys of gold, titanium and nickel-chrome-vanadium to CPTi. Two basic types of materials are used in implant dentistry: metals and ceramics, either in a pure form or a hybrid type[6];

• Ceramic Implants: They are brittle and susceptible to fractures and are not ideally suited for use as implants, their use was primarily for the replacement of single teeth. They do not promote the formation of bone, but exhibit excellent biocompatibility, which allows bone to grow closely onto its surface[6].

• Titanium implants: Titanium biocompatibility, corrosion resistance, relatively light weight, low density, low modulus and high tensile strength make titanium based materials attractive for use in dentistry. Presently there are six different types of titanium based materials used to fabricate dental implants. These materials include four types of CPTi and two titanium alloys, each with its own distinct mechanical and physical properties. CPTi is available in 4 grades. Commercially pure (cp) grade I Ti Ultimate Tensile Strength (UTS) is 240 and Yield Strength (YS) is 170 (99.75% titanium, 0.05% iron, 0.18% oxygen, 0.03% nitrogen, 0.05% carbon and 0.012% hydrogen), cp grade II Ti UTS=345 and YS=275, cp grade III Ti UTS=450 and YS=380 and cp grade IV Ti UTS=550 and YS=483. Titanium alloys include Ti-6Al-4V and Ti-6Al-4V extra low interstitial. The main difference between the 4 grades of titanium and the two alloys is the increasing ultimate tensile strength and the amount of oxygen and iron. Commercially Pure Titanium is also reffered to as unalloyed titanium. All six of these materials are commercially available as dental implants[32,33].

2.2. Osseointegration

OI is currently viewed as the optimum implant-bone interface[4,34], without OI success cannot be obtained. Therefore, great emphasis has been placed on OI and its maintenance. Nevertheless, it is only one component of successful dental implant treatment and may not always prevent from failing. While the absence of OI is equated with treatment failure, its achievement does not guarantee success, which is dependent on the design and performance of the final prosthesis. This may be precluded by an inappropriately placed implant, even if it is integrated[4]. OI is the result of biologic and biomechanical processes and functions[35].

A defining morphological feature of OI is that osteoblasts and mineralized matrix contacts the implant surface even when loads are applied. In contrast, failure of OI or a disintegration of a formerly stable anchored implant can be conceptualized as a failure of the mineralized extracellular matrix directly attached to the artificial surface, since a mechanically competent implant-bone bond is dependent on an intact mineralized interface structure[36].

A number of systemic and local factors have been identified as being associated with the production of an osseointegrated interface. Nowadays, there are less systemic factors that are considered far from OI than was believed. Local factors are as follows[4,24,36];

A- Material: OI was originally believed to be unique to high-purity titanium (CP or CPTi, 99.75%) and this material still forms the basis of the technique; however, it is known that a range of other materials can also form intimate bonds with bone. These include zirconium and some ceramics, particularly hydroxyapatite; however, they have not been as extensively researched as CPTi for dental implant applications.

B- Surface composition and structure: It is thought that CPTi owes its ability to form an osseointegrated interface to the tough and relatively inert oxide layer, which forms very rapidly on its surface. This surface has been described as osseoconductive, that is, conducive to bone formation. Other substrates also have this property and may also stimulate bone formation, a property known as osseoinduction. While the initial bone-implant contact (BIC) with such a material can be more extensive and occur sooner than around CPTi, the long-term benefits are less evident. Implant surface structure is also known to influence cellular behavior, and a range of micro structured surfaces has been shown to modify cell spreading and orientation on the implant, benefiting initial anchorage in bone.

C- Heat: Heating of bone to a temperature in excess of 47°C during implant surgery can result in cell death and denaturation of collagen.

D- Contamination: Contamination of the implant site by organic and inorganic debris can prejudice the achievement of OI. Material such as necrotic tissue, bacteria, chemical reagents and debris from drills can all be harmful in this respect.

E- Initial stability: It is known that where an implant fits tightly into its osteotomy site then OI is more likely to occur. This is often referred to as primary stability, and where an implant body has this attribute when first placed failure is less probable. Screw-shaped implants will be more readily stable than those with little variation in their surface contour. Soft bone with large marrow spaces and sparse cortices provides a less favorable site for primary stability to be achieved.

F- Bone quality: This bone property is well recognized by clinicians but is more difficult to measure scientifically. It is a function of bone density, anatomy and volume, and has been described using a number of indices. Bone volume does not by itself influence OI, but is an important determinant of implant placement.

G- Epithelial down growth: Early implant designs were often associated with down growth of oral epithelium, which eventually exteriorized the device. When the newer generation of CPTi devices was introduced great care was taken to prevent this by initially covering the implant body with oral mucosa while OI occurred.

H- Loading: Early/Late:

. Early loading: There is evidence from clinical studies that where the implant has good primary stability, early loading does not apparently preclude OI.

. Late loading: It has been shown that excessive mechanical loads on an osseointegrated implant can result in breakdown of the interface with resultant implant failure, and it is generally considered that overload is therefore to be avoided.

The biocompatibility of the material is of great importance and a predictor of OI, as it is essential to establish stable fixation with direct BIC and no fibrous tissue at the interface. Pure Titanium (PTi) is widely used as an orthopedic metallic implant material as it is highly biocompatible, it has good resistance to corrosion, and no toxicity on macrophages or fibroblasts, lack of inflammatory response in peri-implant tissues and its surface is composed of an oxide layer and has the ability to repair itself by reoxidation when damaged. Other materials have also been proposed either as alternative to Ti or as alloy systems, including tantalum, aluminum, nionium, nickel, zirconium, and hafnium. The most frequent implant surfaces and types can be subdivided into implants with roughened surfaces with a coating (e.g., titanium plasma-sprayed or hydroxyapatite–coated), implants with machine-processed (e.g., machined or polished) titanium without a coating, and implants with roughened surfaces without a coating (e.g., sand-blasted, acid etched or anodically roughened). Rough surfaces enlarge the implant area in contact with the host bone favoring primary stability, and enhancing peri-implant bone formation compared to smooth surfaces. Roughness positively affects OI and, in particular, it seems to affect directly osteoblast attachment and subsequent proliferation and differentiation[37].

Bone healing around implants involves a cascade of cellular and extracellular biological events that take place at the bone-implant interface until the implant surface appears finally covered with a newly formed bone. These biological events include the activation of osteogenetic processes similar to those of the bone healing process, at least in terms of initial host response. This cascade of biological events is regulated by growth and differentiation factors released by the activated blood cells at the bone-implant interface[2,4,37].

The first biological component to come into contact with an endosseous implant is blood. The blood cells entrapped at the implant interface are activated and release cytokines and other solubles, growth and differentiation factors. Initial interactions of blood cells with the implant influence clot formation. Platelets undergo morphological and biochemical changes as a response to the foreign surface including adhesion, spreading, aggregation, and intracellular biochemical changes such as induction of phosphotyrosine, intracellular calcium increase, and hydrolysis of phospholipids. The formed fibrin matrix acts as a scaffold (osteoconduction) for the migration of osteogenic cells and eventual differentiation (osteoinduction) of these cells in the healing compartment. Osteogenic cells form osteoid tissue and new trabecular bone that eventually remodels into lamellar bone in direct contact with most of the implant surface (OI)[2,4,37].

The newly formed network of bone trabeculae ensures the biological fixation of the implant and surrounds marrow spaces containing many mesenchymal cells and wide blood vessels. A thin layer of calcified and osteoid tissue is deposited by osteoblasts directly on the implant surface. Blood vessels and mesenchymal cells fill the spaces where no calcified tissue is present[2,4,37].

The newly formed bone was laid down on the reabsorbed surface of the old bone after osteoclastic activity. A few days after implantation, even osteoblasts in direct contact with the implant surface began to deposit collagen matrix directly on the early formed cement line/lamina limitans layer on the implant surface. Osteoblasts cannot always migrate so rapidly to avoid being completely enveloped by the mineralizing front of calcifying matrix[2,4,37].

The early deposition of new calcified matrix on the implant surface is followed by the arrangement of the woven bone and bone trabeculae. This is appropriate for the peri-implant bone healing process as it shows a very active wide surface area, contiguous with marrow spaces rich in vascular and mesenchymal cells. Marrow tissue containing a rich vasculature supports mononuclear precursors of osteoclasts so bone trabeculae remodel faster than cortical bone[2,4,37].

Initially, rapid woven bone formation occurs on implants to restore continuity, even though its mechanical competence is lower compared to lamellar bone based on the random orientation of its collagen fibers. Woven and trabecular bone fill the initial gap at the implant-bone interface. The early peri-implant trabecular bone formation ensures tissue anchorage that corresponds to biological fixation of the implant. This begins at 10 to 14 days after surgery. Biological fixation differs from primary (mechanical) stability that is easily obtained during the implant insertion. Biological fixation of the implant involves biophysical conditions such as primary stability that is implant mechanical fixation, biomimetic implant surface and right distance between the implant and the host bone[2,4,37].

Peri-implant bone contains regular osteons and host bone chips enveloped in mature bone. The implant surface is covered with flattened cellsak. The bone-implant interface shows inter-trabecular marrow spaces delimited by titanium surface from one side and by newly formed bone from the other one rich in cells and blood vessels. Host bone chips between the implant and the host bone cavity presumably occur from the surgical bur preparation or implant insertion. These are enveloped in a newly formed peri-implant trabecular bone, and seem to be involved in trabecular bone formation during the first weeks, i.e., in the biological fixation of the implant, by improving and guiding peri-implant osteogenesis as osteoconductive and osteoinductive biological material. Therefore, it may be useful in clinical practice not washing with a saline solution or aspirating the bone cavity before or during the implant insertion[2,4,37].

Major factors for the failure of peri-implant osteogenesis include the decreased number and/or activity of osteogenic cells, the increased osteoclastic activity, the imbalance between anabolic and catabolic local factors acting on bone formation and remodeling, the abnormal bone cell proliferation rate and response to systemic and local stimuli and mechanical stress, and the impaired vascularization of the peri-implant tissue. Vascularization is of critical importance for the process of OI. Differentiation of osteogenic cells strictly depends on tissue vascularity. Ossification is also closely related to the revascularization of the differentiating tissue. Since aging impairs angiogenesis, biomaterial OI is also reduced. In the elderly, the association of impaired angiogenesis with osteoporosis increases the implant failure risk[2,4,37].

Bone in contact with the implant surface undergoes morphological remodeling as adaptation to stress and mechanical loading. The turnover of peri-implant mature bone in osseointegrated implants is confirmed by the presence of medullary or marrow spaces containing osteoclasts, osteoblasts, mesenchymal cells and lymphatic/blood vessels next to the implant surface. During the remodeling of the peri-implant bone, new osteons circle around the implant with their long axes parallel to the implant surface and perpendicular to the long axis of the implants. Osteoid tissue is produced by osteoblasts suggesting that osteogenesis is underway. The remodeled bone can extend up to 1 mm from the implant surface[38-40].

Bone is classified as either compact bone or spongy bone. Compact one consists of lamellae or layers of cells, and a matrix made of inorganic and organic components. The cells present are called osteocytes. They are located in lacunae and have cell processes for nutrient diffusion within small channels. Compact bone has outer circumfuruncial lamellae, inner circumfuruncial lamellae, haversian lamellae, and interstitial lamellae, which account for the hardness and density of this bone. Compact bone is covered by periosteum and has collagen fibers, osteoblasts, and osteoclasts. Periosteum is attached tightly to the bone surface by sharpey's fibers and serves as protection for bone. Osteoblasts and osteoclasts in periosteum are involved with remodeling, bone resorption and bone apposition[41].

Spongy bone has a loosely organized porous structure. The structure of the trabecular system is optimized to transfer the loads through the bone by a dynamic feedback between load perception of cells and their subsequent cellular reaction. The trabeculae are covered by osteoblasts and bone-lining cells. Whereas osteoblasts actively secrete the components of the extracellular matrix in order to build up bone tissue, bone-lining cells are in an inactive state. They cover surfaces where neither bone formation nor resorption is present. In contrast to the former cells, which originate from local osteoprogenitor cells, osteoclasts arise from the fusion of mononuclear precursors. They can be located in cortical as well as in spongy bone. Their presence is indicative of bone resorption activities[31].

The difference between cortical and spongy bone is not only structural also functional. The differences in their histological and ultra structural appearance are related to their primary functions: the cortical part of bone provides mechanical and protective functions, whereas spongy bone is more involved in metabolic functions (e.g. calcium homeostasis). Both aspects (structural and metabolic) are closely related to the features of the mineralized extracellular matrix[31].

Spongy bone with less density and less hardness is not a stable base for primary fixture fixation. Only compact bone can provide a stable base for primary fixture fixation. When the bone healing progresses well, the bone cells present in spongy bone form with a high density bone along the fixture surface. In the mandible, the spongy bone is denser than the spongy bone present in the maxilla. With primary fixation in compound bone, OI in the maxilla requires a longer healing period due to the difference in spongy bone density. When performing surgical procedures in the maxilla, it is crucial to obtain proper primary fixation for successful OI[31].

2.3. Flap Techniques in Dental Implant Surgery

Most surgical techniques for placing an implant are proceeded by an incision, often on the alveolar crest, and then elevation of the mucosa. After placement of the implants, the mucosa is sutured around or, in the two-stage technique, over the implants. After a healing period, the mucosa is re-opened and the transmucosal components are connected[42].

Branemark et al, originally advocated using flaps in corperating vestibular incisions, buccal flaps initiated with pericrestal incisions have been shown to provide a practical and effective approach to implant placement, abutment connection and ancillary grefting procedures. Typically, the buccal flap is outlined by a pericrestal incision and one or more vertical releasing incisions located at the mesial and distal extend of the side. The surgeon simply adjusts the position and bevel of the pericrestal incision to accommodate for submerged or non-submerged implant placement and abutment connection procedures. The use of vertical releasing incisions, especially in single tooth implant sites where bone grafting is required, is often advantageous for exposure of the surgical site and to allow proper repositioning of the surgical flap without tension[14,15]. Another flap design is the mini-flap procedure. This procedure is significantly safe and that flap elevation can be avoided in placing implant. Moreover, it has been reported that mucoperiosteal flap elevation may cause postoperative bone resorption[43].

In recent years there has been some interest in developing techniques that can provide function, esthetics, and comfort with a minimally invasive surgical approach. Flapless surgery involves accessing the bone by either punching out a small amount of soft tissue, just the amount required for osteotomy preperation and implant placement, or prepairing the osteotomy side by drilling directly through the soft tissue. The flapless surgery minimized bleeding and swelling. Flapless technique is one of the latest minimally invasive surgical methods of implant placement without raising a mucoperiostal flap. Procedure has many advantages for the patient as well as for the surgeon such as shorter surgical treatment, minimal bleeding, less postoperative discomfort for the patient, possibility of immediate loading of the inserted implant, faster procedure of implant placement and less time needed for complete implant-prosthetic restoration. Two-stage technique in dental implantology, due to raising full-thickness periosteal flap results in the possibility of marginal bone loss and soft tissue recession, while flapless technique has a potential to minimize crestal bone loss and soft tissue inflammation. In addition, avoiding the creation of a mucoperiosteal flap results in less postoperative patient discomfort and possible scar tissue formation. Leaving the periosteum intact on the buccal and lingual aspects of the ridge maintains a better bloody supply to the site, reducting the likelihood of resorption[44-46]. Despite many benefits, however, flapless implant surgery has generally been perceived as a blind procedure because of the difficulty in evaluating alveolar bone contours and angulations. Therefore, this procedure has been limited to straight-forward cases in which the width of the bone crest is favorable and there is no considirable undercut[47,48].

2.4. Radiological Assessment

Radiographic analysis has played an important role in determining treatment outcome because it offers the only non-invasive method of evaluating the hard tissue response to therapy. Although the limitation of radiographic analyses has been well described, several techniques have been derived to assess longitudinal bone loss. Some of these methods have been applied to the assessment of regenerative therapy. Linear radiographic measurements provide a one-dimensional perspective for evaluating bone height changes in the defect area[49-52].

Current radiation protection regulations, both nationally and internationally, are based on justification and the ALARA principle (as low as reasonably achievable). This implies that every radiographic examination must be carried out to the benefit of the patient by application of the lowest possible dose. Therefore, the selection of imaging technique is of important[16].

Assessment of available alveolar bone and bone morphology, with clinical examination and palpation of the bone ridge at the implant site, is essential in preoperative implant planning. Various pre-surgical imaging techniques, including conventional radiographs PA and PN radiographs, tomography, cephalometry) and computed tomography (CT) are proposed to localize the mandibular canal[53]. An important part of the diagnosis is determining if sufficient bone is available for the placement of implants. When there are teeth approximating the edentulous areas, it is important to determine if the teeth and bone are free from pathology. It is also important to locate vital anatomic structures that can interfere with implant placement such as the maxillary sinus, inferior alveolar canal, mental foramena, and approximating roots. Radiographic images are used to assess available bone sites for implant placement since the number, angulation, and dimensions (length and width) of implants is dependent on the available bone volume. Clinicians also use radiographs to identify bone quality. To aid in the treatment planning of implant patients, a classification system has been developed for both the maxilla and mandible related to the degree of resorption and morphology of the residual ridge[53,54].

The assessment of bone sites for implant placement can sometimes be made using basic radiographs such as PA and/or PN radiographs and other times advanced radiographs are required. Various diagnostic imaging techniques are described for the assessment of bone prior to implant placement and indications[55]. One of the objectives of monitoring endosseous implants is to determine the changes in peri-implant bone height that occurred over some time interval and to what extent[54].

2.4.1. Panoramic Radiography

The great advantage of PN radiography is the broad overview provided. Pathologic changes, other than caries, in regions not assigned for implant placement can be detected and treated, which corresponds with the philosophy that implant treatment should be carried out only in patients undergoing comprehensive dentistry. Because it is a survey radiogram, PN radiography allows for assessment of structures such as the maxillary sinus or the course of the mandibular canal, and it provides the possibility for vertical measurements with sufficient accuracy if the magnification factor of the PN X-ray unit is known. In addition, the better overview helps to indicate the need for intraoral X-rays for questionable sites to elucidate details. For instance, to judge the periodontal situation of neighboring teeth in an implant recipient site, the sharper delineation of a PA radiograph may be necessary [16,50,56].

However, the need for additional PA radiographs can be significantly reduced when a PN device is used, which provides better image quality because of optimized layer thickness. Thus, to achieve a comprehensive examination, PN radiography should be performed as a standard radiographic examination in partially edentulous and completely edentulous patients; subsequently, PA radiographs will help to elucidate details from objects not clearly visible in the PN radiograph. In patients in whom determination of the bone width is possible by clinical findings, these imaging techniques may remain the only radiographs necessary for treatment planning[16,50,56].

PN radiographs are commonly used for diagnostic purposes in implantology[53]. PN radiographs provide useful preliminary evidence of the general status of the dentition and the relationship between alveolar bone, basal bone, and key anatomical structures that may preclude routine implantation[57].

Indications/Use(s)[55]

• Initial evaluation of bone dimensions and in screening for the detection of pathologic conditions when planning for dental implants.

• Provides approximate information regarding the location and dimensions of the maxillary sinus, nasal cavity, inferior alveolar canal, and mental foramen.

Limitations[55]

• Magnification of up to 25% has been reported which results in a linear measurement error of up to 3.30 mm.

•The poor image resolution and unpredictable image distortion limits its usefulness when assessing bone adjacent to implants during follow-up.

• May provide information to determine vertical dimension, but is unreliable for measurements in the horizontal direction and for assessing bone quality.

Batenburg and colleagues reported that atrophy-related elevation of the floor of the mouth makes PA radiography difficult or rules it out altogether. In such situations, PN imaging was found to be superior to PA small-format radiography, which was not applicable in all patients[59].

2.4.2. Periapical Radiography

PA radiographs provide the contrast, resolution, and delineation of objects, also known as the “gold standard”. Although absence of the screen requires a higher dose, the effective dose and biologic risk for the patient from an E-Speed PA radiograph of the molar region is still 5 times lower than that of a PN radiograph. However, considering its limited overview, a PA radiograph appears to have a restricting disadvantage because its incomplete radiographic findings[16].

The PA radiograph is valuable for estimating the mesiodistal dimension of a potential implant site and to obtain a preliminary estimate of vertical dimensions[57]. PA radiographs are particullary well for longitudinal assessment of implants. There has been considerable interest in using quantitative digital substraction radiography, as a non-invasive means of evaluating and quantifying changes in alveolar bone mass, occuring as a result of dental treatment such as an implant procedure. These diagnostic procedures measuring changes in mineral density are regarded as sensitive methods for predicting future loss of crestal height[59].

Indications/Use(s)/Advantages[55]

- Allows accurate horizontal measurement such as the proximity of adjacent roots.
- Permits an accurate evaluation of the bone response adjacent to dental implants.
- Recommended to evaluate passive fit between implant components.
- High quality.
- Low cost.
- Low radiation exposure.
- Readily available.

Limitations[55]

- Vertical and horizontal linear measurements are accurate if paralleling techniques are used to prevent image distortion.

- Does not provide a cross-sectional view of the bone and only a small area of the jaw is visible.

2.4.3. Advanced Radiographs

Using a radiograph template, the selected advanced radiograph is made and analyzed. The bone dimensions are measured and the location of the bone relative to the prosthetic teeth can be analyzed. Linear tomograms and CT are the 2 most common types of advanced radiographs used in conjunction with implant dentistry[55].

The available bone volume cannot be judged only from PN radiography. In many situations, bone width can be determined by clinical examination, as previously described. However, in patients in whom soft tissue structures prevent proper assessment of the jaw, the surgical site may reveal another bone volume than that expected by the preoperative examination. With conventional tomography, it is possible to obtain cross-sectional images that can be used to determine bone width. Contemporary machines for PN radiography generally include the possibility of curved linear tomography, parallel linear tomography, or spiral tomography. There are also x-ray units that include a coordinate system for object localization and a wide selection of dental and maxillofacial imaging programs. CT uses software that performs multiplanar reformatting (CT/MPR) from axial slices, yielding cross-sectional images that are perpendicular to the curvature of the dental arch. In addition to these images, 3 to 5 reformatted image layers are shown parallel to the dental arch, which are called PN views. With both conventional and CT, it is possible to obtain information about the width, height, and inclination of the alveolar process; anatomic and topographic structures; and, to some extent, the trabecular architecture. Objects seem to be better delineated; the microstructure, however, seems to be worse, and faint objects are not detectable. Comparative studies reporting on the image quality of different systems should be carried out to elucidate the significance of differences. A decisive difference between conventional and CT is that conventional tomography generally applies a lower dose of radiation to the patient[16].

2.5. Low Level Laser Therapy

A laser is a device that produces an intense, highly parallel beam of coherent light. It is named after the composition of the excitable medium from which the laser beam emanates [e.g., carbon dioxide (CO), argon (Ar), GaAlAs, HeNe, GaAs. Since the late 1970s, lasers have been studied in oral and maxillofacial surgery for the treatment of soft tissue lesions and occasionally for the cutting of bone. Light emitted surgical lasers are generally in the visible and infrared regions of the electromagnetic spectrum and is nonionizing. This radiation must be clearly differentiated from ionizing radiation exemplified by x-rays and gamma rays, which may produce deleterious effects on living tissue. Therefore, patients, medical personnel and particularly pregnant women working with or around lasers may do so without the risks associated with x-rays. Each different type of laser produces a different wavelength (color) of light that is absorbed by specific target chromophores within tissues. The biologic effect of this light on tissue is dependent upon wavelength, energy level of the beam, and absorption characteristics of the tissue receiving this energy. For example, the CO laser (10,600 nm—middle infrared) light is absorbed heavily by water. Since human tissue is mostly water, it absorbs virtually all of the laser energy without significant reflection or backscatter from the surgical site. However, when this same light comes into contact with shiny surgical instruments, reflection will occur. In tissue, the depth of this laser's photovaporization or photocoagulation effect is directly dependent on the power density (w/cm2), which is determined by the intensity of the focused beam, and the energy density (j/cm2), which determines the rate at which energy is delivered to the tissue. The thermal damage produced adjacent to the surgical site by diffusion of heal can be reduced to a range of micrometers, depending on the energy density used. Irreversible thermal damage adjacent to the zone of photovaporization is minimized by using the highest controllable power density for the shortest amount of application time. Hazards of the CO laser in oral and maxillofacial surgery include corneal, scleral, and cutaneous injury ranging from transient pain to severe burns. Both the patient and the medical personnel are at risk for these injuries[60].

GaAlAS diode lasers have been used for experimental and clinical studies on bone repair. IT is known to be a high tissue-penetration laser because hemoglobin and water have a low coefficient of absorption for it. The GaAlAs laser wavelength, delivered to the skin and oral mucosa, penetrate the tissues and is thought to reach the nerve lying 4-8 mm under oral mucosa and bone, it is also useful adjunctive treatment modality for trigeminal nerve paresthesia[12].

GaAs lasers allows deep penetration into subcutaneous tissue because of low absorption by water or skin pigments[12].

HeNe gas lasers are well established, widely commercially available, and relatively low cost. HeNe lasers are used for promoting epithelial growth in various medical disciplines and for promoting peripheral nervous system recovery. Its affect on healing tissues, increases in collagen, other extracellular components, RNA synthesis, or blood supply[12].

The argon laser emits a blue-green light of 488 and 514 nm, which is selectively absorbed by the red chromophore. oxyhemoglobin at 488 and 540/577 nm (double absorption peak). It is delivered to the target tissue by an optical fiber. This laser, depending on its spot size, power, time of application, and resulting energy density, can photovaporize or coagulate tissue with up to several millimeters of thermal damage adjacent to the zone of clinical laser treatment. The optical hazards of the argon laser include retinal and skin burns[60].

The neodymium:yttrium-aluminum-garnet (Nd:YAG) laser emits an invisible 1060-nm (near-infrared) light that is heavily absorbed by pigmented tissue. It can photovaporize or photocoagulate almost all biologic tissue with which it comes in contact. The zone of thermal damage of the Nd:YAG laser may extend as much as 1 cm beyond the surgical target site consequent to a deep penetrating effect that is not observable at the time of treatment. This powerful laser is delivered to the surgical site by an optical fiber or contact probe. Optical hazards of this laser are similar to that of the argon laser and include retinal and skin hazards. The greatest source of danger in surgery of the oral cavity is the endotracheal tube itself. Special care must be taken to prevent the tube from coming into contact with the laser during surgery because ignition of the endotracheal tube produces a tire with a blowtorch effect inside the patient's airway. It is important to have an airtight endotracheal tube with a metal reflective exterior[60].

The regulatory mechanism of LLLT is not yet clearly understood. It is photochemical in nature, with the energy probably being absorbed by intracellular chromophores and converted to metabolic energy, most likely involving the respiratory (cytochrome) chain[11,61]. A possible biochemical explanation of LLLTs stimulating effect is an increase of ATP synthesis in low-energy laser irradiated cells cultivated[61].

LLLT has been advocated as a modulator of tissue repair, and different stimulatory effects have been described. However, the precise mechanism and molecular basis of such effects remain unclear. Several studies have investigated the properties of LLLT since the development of lasers in the 1960s. Among the clinical indications for the technique are stimulation of soft tissue repair in lesions such as herpes and oral mucositis, enhancement of tissue healing after oral surgery, and promation of pulpal repair. This therapeutic resource has also been recommended for enhancement of bone repair and OI, indicating its use after endosseous implant placement[62].

It is well established that the Ebrium-doped:Yttrium-Aluminum-Garnet (Er:YAG) laser, emitting at a wavelength of 2.94μm, possesses suitable properties not only for soft tissue therapy but also for hard tissue treatment due to its characteristic wavelength that is highly absorbed by water. With the Er:YAG laser, it has been demonstrated that the effective removal of calculus and plaque on contaminated abutments is possible under suitable irradiation parameters without titanium surface damage or major temperature elevation[63].

The stimulatory effects of LLLT have been widely published for the treatment of chronic ulseration as well[64].

3. MATERIAL AND METHODS

A healthy story questionnaire, oral examination, radiographic examination and a patient interview determined the suitability of subjects for the study. In this study, all implants underwent a 3-4 months OI healing period before the second stage surgery to uncover the implants. Implants were inserted in bone-level and submerged position. After uncovering, a minimum of 7 days, soft tissue healing period was allowed before prosthetic procedures were begun. The radiographs were converted to 14.9 MegaPixel digital images with a calibrated SONY α 350 Digital SLR Camera with CCD sensor.

Patients had no history of any systemic disease or using any medications. Patients of the study were referred to the Gazi University, School of Dentistry, Department of Oral and Maxillofacial surgery, between July 2008 and May 2009. All the patients of the study were systemically healthy and non-smokers. The study protocol was reviewed and approved by the Local Ethics Committee. Informed written consent was obtained from all patients. There were a total of 27 patients and their age was between 17-68, the mean age was (36.5±13.62). Among 27 patients, 20 of them were female (age range 17-68 years) and seven were male patients (age range 25-52).

Study criteria included the following:

- Absent of systemic disease
- Surgical site that would not require bone augmentation or sinus grafting
- Agreed to follow-up visits for four months
- Signed surgical consent forms
- No congenital bone deformity

Patient health story questionnaire.

Patient; ______________________________________ **Date:** ____________

Name Surname:……………………………..……………………………

Age :…………………… Sex: **F - M**

File No :……………………………………………………………..

Address :………………………………………………………………

Telephone :…………………… Mobile:..……………………………

Medical History:

………………………………………………………………………………

If on medications, Name?:……………………………….…………………

Patient must be systemic disease free and non-smoker.

No. Of implant placed in the Flap group:………………………………………

No. Of implant placed in the Mini-Flap group …………………….………

Control days:

1stday……………………………………PA+PN, Laser

5thday……………………………………Laser

7thday……………………………………Laser

1.month...………………………………..PA+PN film

3.month...………………………………..PA+PN film(Mandible)

4.ay………………………………………PA+PN film(Maxillae)

Other important considerations:……….…………………………..…………..

Purpose of the study was explained to all patients, and surgical consent forms were signed. Prior to treatment PA and PN radiographs were taken. Patients were anesthetized using 2cc 2.5% articaine hidrochlorur containing (ultracaine DS-Hoechst, Frankfurt, Germany) 2cc.

Patients were divided into two groups according to the laser application, each group was divided to two subgroups A and B:

Group A: Include 15 patients with conventional flap design.

Group B: Included 12 patients with mini-flap design.

Conventional flap design was a horizontal insicion on the crestal bone and it released mesially with a vertical insicion. The mini-flap had only a horizontal insicion applied on the top of the crestal bone. After the reflection of the conventional flap and the mini-flap, the drilling was performed using special drills. After the drilling, GaAlAs diode laser 830 nm and output power of 94 mw was applied for 39 seconds intraoperatively in one side only to the cavity and the other side was the control group. The cavity was not irrigated after the laser application.

Standard drilling procedures according to the manufaturer’s recommendations (Tidal spiral® dental implant systems) were followed using a minimized countersinking protocol. Immediately after drilling, the socket was irradiated in the laser group. A GaAlAs diode BTL 2000 portabe laser (USA) (Picture 1), with a wavelength 830 nm and a fluency of 3.0 J/cm², was employed for 39 seconds in every session as suggested by the manfucturer protocol. All implants were inserted with a minimum torque of 30Ncm. After the implant insertion the insicion was sutured with a 4/0 silk, all implants were totally submerged inserted.

Irradiation was also applied to the socket intraoperatively and immediately after the suturing (Picture 2), and was applied on the 5th and 7th day. All irradiations were performed by the same operator. Nevertheless, implant in the opposite side did not receive laser irradiation, as being the control side.

Every patient was radiographed immediately with PN and PA parallel technique radiograph. Radiographs were also taken after one and three months in the mandible, and after one and 4 months in the maxilla.

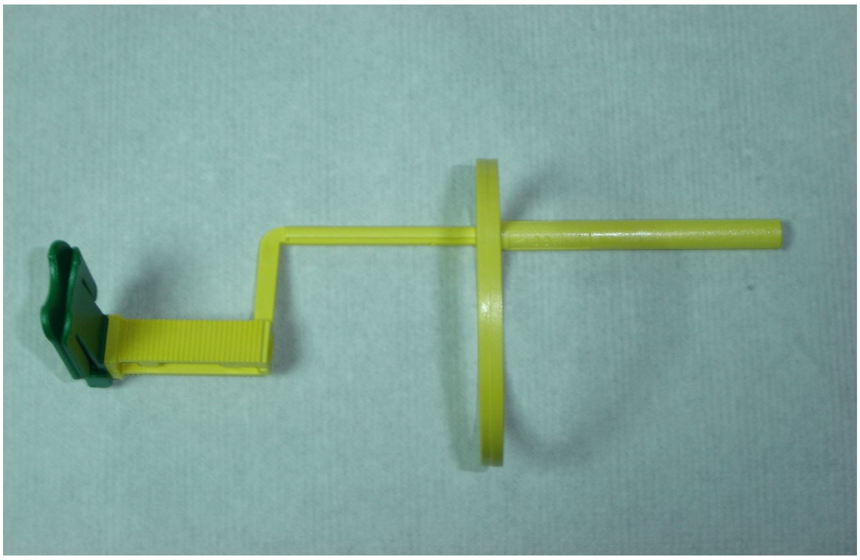
Postoperatively the patients took 1 g of amoxicillin BID or Clyndamycine 150mg QID if allergy present and then 275mg Naproxen Sodium and chlorhexidin TID to be used the following days of the operation.

Scion Image Real Convertor programme 5.5 was used to measure vertical crestal bone loss around the dental implant.

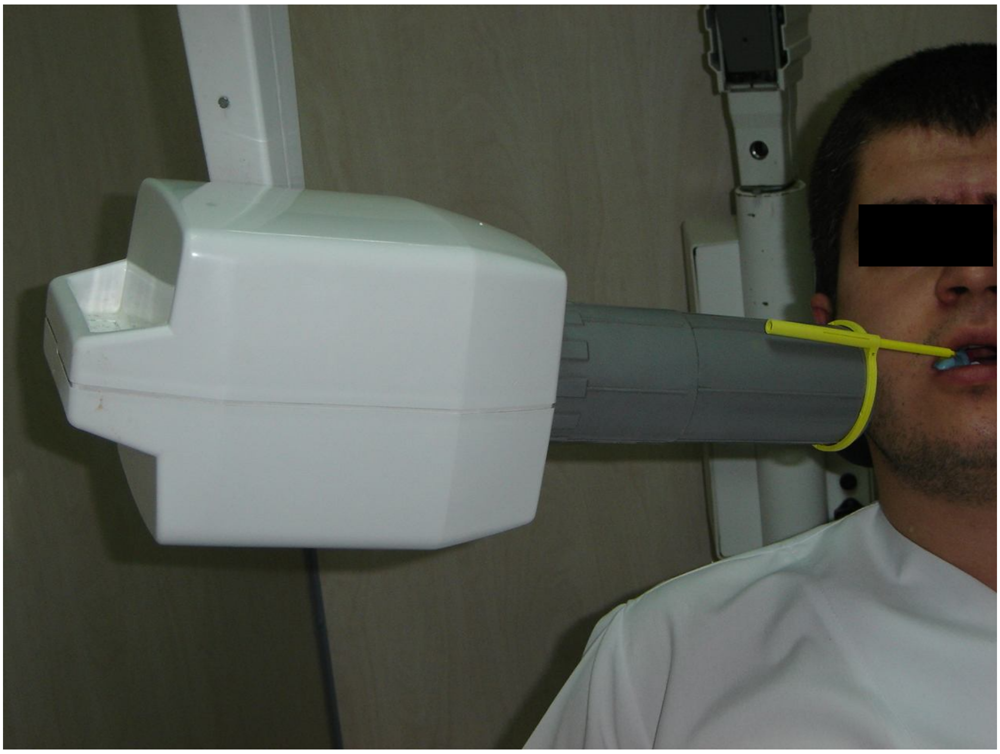
Picture 1: GaAlAs diode BTL 2000 portabe laser

Picture 2: Laser applied immediately after suturing

PA radiographs with a parallel technique were taken with single-packed Kodak dental films on a radiograph machine (Trophy CCX, Vincennes, France) operating at 70 kVp and 8 mA, having 2.5 eq aluminium filtration and a 0.8 x 0.8mm focal spot, according to the manufacturer's exposure recommendations, with the bisecting technique to obtain radiographs. The radiographs were processed in an automatic roller transport processor machine (Velopex Extra-X Medivance Instruments Ltd, London, UK) with fresh chemicals. In able to stabilise the angle of the PA radiographs. Anterior and posterior Kerr Super-Bite Switzerland film holders were used (Picture 3 and 4). Every patient had individual partial impression which was obtained during the first pre-operative PA radiographs taken. In order to use the software, radiographs have to be calibrated using a radiopaque reference device of known dimensions that is included in the image during exposure of the radiographic image of the patient. The reference device is placed in the oral cavity using a custom fabricated stent to hold it in place. The digital PN images were taken by the Orthoralix 9200 DDE machine (Gendex Dental Systems, Milan, Italy). The digital PN images were taken at 70-74 kVp, 4-10 mA and 12 s according to patient weight in order to maintain consistent radiographic density. The digital images were taken at 16-bit greyscale levels and saved as TIFF files.



Picture 3: Anterior film holder



Picture 4: Posterior film holder

The digital PN images were displayed on a 17 inch Super VGA monitor with a screen resolution of 1024 x 768 pixels. The contrast and brightness of the images were set to 100 and 0, respectively. The computer was an Intel Pentium® having 256 MB of RAM. The operating system of the computer was Windows XP (Microsoft XP, v2002) and the digital imaging software used for the Orthoralix DDE images was VixWin Pro (Gendex Dental Systems, vl 5). All unfiltered and filtered digital PN images were evaluated under subdued lighting conditions and the viewing distance was kept at approximately 70cm.

After digitalizing the images, the distance between the apex of the implant and the apical level of the marginal bone that was in contact with the implant was measured. To correct the system-inherent magnification, the implant length and the reference metal ball was measured on radiographs and divided by the actual implant length and the reference metal ball to determine the magnification of the images. Measurements were made mesially and distally for each implant and the mean value was calculated.

The data obtained were processed using a statistical software package of SPSS 17 for Windows, SPSS INC. IL, Chicago, USA. Cohort comparisons were made by the repeated measures of ANOVA tests. Significance was accepted at a probability level of $p<0.05$.

4. RESULTS

In this study, 54 titanium dental implants were placed in total of 27 patients. Demographic distribution of the patients enrolled to our study as follows (Table 1);

Table 1: Location of implants applied (n(%))

Location of Implants	**n=54**
Mandible and Maxilla	12 (22.2)
Mandible	40 (74.1)
Maxilla	2 (3.7)

Table 2: Correlations of implants applied by flap designs, by age and then by gender [Av±SS (Min-Max), n]

	Group Mini-flap (n=24)	**Group Flap (n=30)**	**p**
Age (Min:17- Max:68)	31.75 ± 9.29 (19-49)	40.40 ± 15.52 (17-68)	0,152
Gender (20 Female/7 Male)	8/4	12/3	0,662

Table 2 displays the correlation of the number of implants applied by two different flap designs and also by age (Min:17- Max:68), and by gender (20 females, 7 males).

Table 3: Implant failure and its correlation to age and gender

	Mini-Flap Group (n=24)	**Flap Group (n=30)**
Age	r=-0.218 p=0.495	r=0.622 p=0.013*
Gender	r=-0.426 p=0.167	r=0.354 p=0.196

* p < 0.05

Table 3 displays the correlation between failure of implants and age, and gender in different flap groups. There was no significant difference between gender and flap designs (p›0.05). However, there was a significant difference between the age and flap group (p<0.05), while the age and mini-flap group showed no significant difference (p>0.05) when the statistical analysis was done within the group.

Table 4: Detection of bone loss on PA radiographs in irradiated and non-irradiated groups using normal flap design.

PA	Day	Laser	No-Laser	p	p^L	p^{NL}
Flap	1	11,195±0,459 (10,248-12,141)	10,183±0,496 (9,160-11,206)	0,095	-	-
Flap	2	10,413±0,510 (9,361-11,465)	9,376±0,516 (8,310-10,442)	0,094	0,015*	0,000*
Flap	3	10,084±0,492 (9,069-11,100)	8,969±0,508 (7,921-10,017)	0,072	0,057 0,004*§	0,016* 0,000*§

p Difference between the laser and non-laser group when compared
§ Difference between Day 1 and Day 3 within the group
(p^L Laser. group, p^{NL} No-Laser Group)
* $p < 0.05$

Measurements done on PA radiographs determined that there was no significant difference between the irradiated and non-irradiated implants in the flap group in day 1, 2 and 3 (p>0.05). However, there was a significant difference in day 1-2 and 1-3 in the irradiated group (p<0.05). Moreover, in the non-irradiated group there also found to be a significant difference in day 1-2, 2-3 and 1-3 (p<0.05).

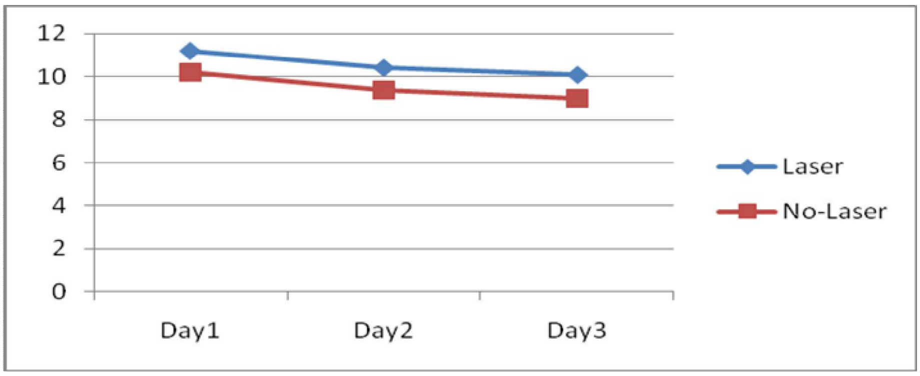


Figure 1: Comparison between L and N.L. group with PA in the flap group

Table 5: Detection of bone loss on PA radiographs in irradiated and non-irradiated groups using mini-flap design.

PA	Day	Laser(n=27)	No-Laser(n=27)	p	p^L	p^{NL}
Mini-Flap	1	11,714±0,516 (10,650-12,779)	11,313±0,557 (10,162-12,463)	0,545	-	-
3 **Mini-Flap**	2 (	10,876±0,573 (9,693-12,059)	10,671±0,581 (9,472-11,870)	0,762	0,021 *	0,004 *
9 **Mini-Flap**	3 (	10,065±0,553 (8,924-11,207)	10,176±0,571 (8,998-11,355)	,0 ,869	0,000 * 0,000 *§	0,009 * 0,000 *§

p Difference between the laser and non-laser group when compared
§ Difference between Day 1 and Day 3 within the group
(p^L Laser. group, p^{NL} Non-Laser Group)
* $p < 0.05$

There was no significant difference between the irradiated and non-irradiated implants in the mini-flap group in day 1, 2 and 3 (p>0.05). However, there was a significant difference on day 1-2, day 2-3 and day 1-3 when laser and non-laser groups were statistically assessed within the group (p<0.05).

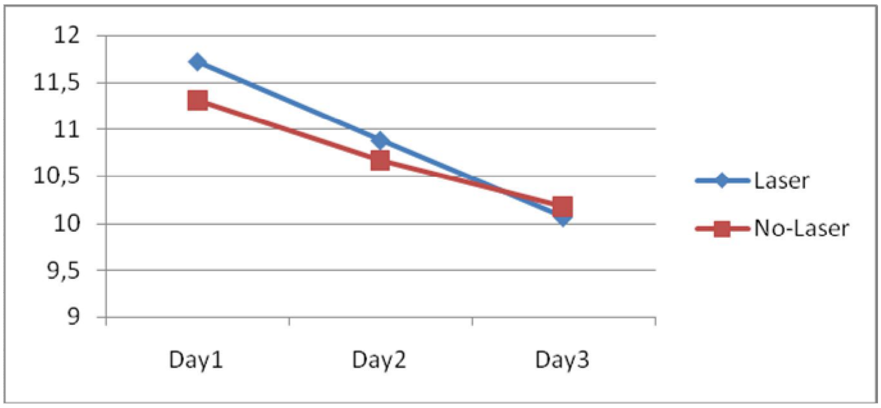


Figure 2: Comparison between L and N.L. group with PA in the mini-flap group

Table 6: Detection of bone loss on PN radiographs in irradiated and non-irradiated groups using normal flap design.

PN	Day	Laser (n=27)	No-laser(n=27)	p	p^L	p^{NL}
Flap	1	11,453±0,448 (10,529-12,378)	10,301±0,479 (9,313-11,289)	0,048*	-	-
3Flap	02	10,695±0,450 (9,765-11,625)	9,521±0,444 (8,310-10,442)	0,029*	0,000*	0,000*
Flap	3	10,369±0,465 (9,409-11,329)	8,997±0,458 (8,052-9,942)	0,030*	0,008* 0,000*§	0,002* 0,000*§

p Difference between the laser and non-laser group when compared
§ Difference between Day 1 and Day 3 within the group
(p^L Laser. group, p^{NL} Non-Laser Group)
* $p < 0.05$

There was a significant difference between the irradiated and non-irradiated groups in the flap group in day 1, 2 and 3 (p<0.05). In addition, there was a significant difference on day 1-2, day 2-3 and day 1-3 when laser and non-laser groups were statically assessed within the group (p<0.05).

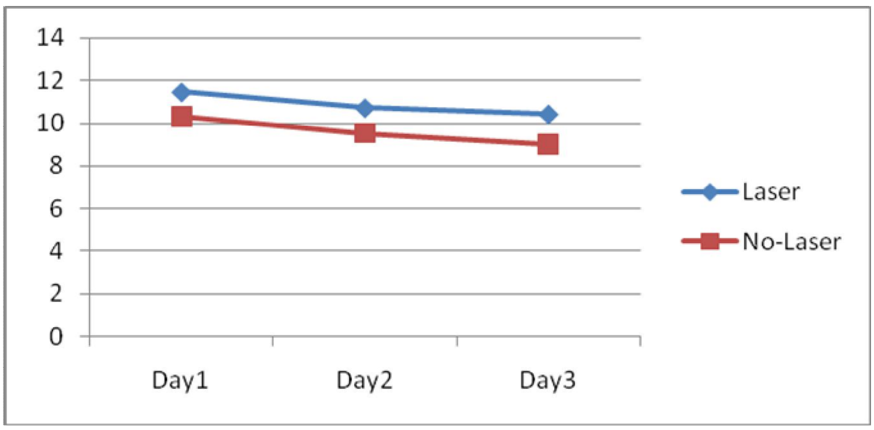


Figure 3: Comparison between L and N.L. group with PN in the flap group

Table 7: Detection of bone loss on PN radiographs in irradiated and non-irradiated groups using mini-flap design.

PN	Day	Laser(n=27)	No-Laser(n=27)	p	p^L	p^{NL}
Mini-Flap	1	11,721±0,504 (10,681-12,761)	11,271±0,538 (10,158-12,382)	0,475	-	-
Mini-Flap	2	10,970±0,507 (9,924-12,016)	10,574±0,500 (9,542-11,606)	0,493	0,001*	0,001*
Mini-Flap	3	10,437±0,523 (9,357-11,517)	10,149±0,515 (9,086-11,212)	0,672	0,000* 0,000*§	0,028* 0,000*§

p Difference between the laser and non-laser group when compared

§ Difference between Day 1 and Day 3 within the group

(p^L Laser. group, p^{NL} No-Laser Group)

* $p < 0.05$

There was no significant difference between the irradiated and non-irradiated groups in the mini-flap group in day 1, 2 and 3 (p>0.05). However, there was a significant difference on day 1-2, day 2-3 and day 1-3 when laser and non-laser groups were statically assessed within the group (p<0.05).

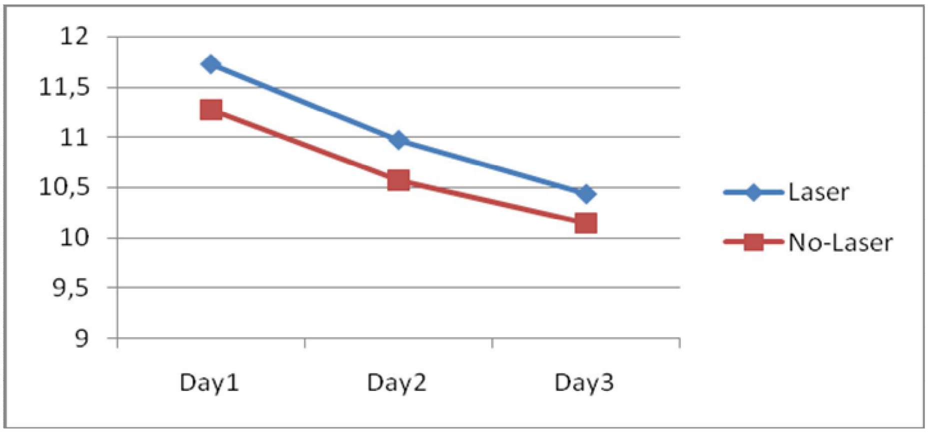


Figure 4: Comparison between L and N.L. group with PN in the mini-flap group

Table 8: Assessment of bone loss on PA radiographs for both flap designs in the irradiated group.

Laser	Day	Flap(n=27)	Mini-Flap(n=27)	p	p^F	p^{MF}
PA	1	11,195±0,459 (10,248-12,141)	11,714±0,516 (10,650-12,779)	0,470	-	-
PA	2	10,413±0,510 (9,361-11,465)	10,876±0,573 (9,693-12,059)	0,563	0,015*	0,021*
PA	3	10,084±0,492 (9,069-11,100)	10,065±0,553 (8,924-11,207)	0,980	0,057 0,004*§	0,000* 0,000*§

p Difference between the Flap and Mini-Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^F Flap group, p^{MF} Mini-Flap Group)
* $p < 0.05$

There was no significant difference between the flap and the mini-flap group in day 1,2 and 3 for bone loss (p>0.05). However, there found to be a significant difference in the flap group only day 1-2 and day 1-3 (p>0.05). Moreover, in the mini-flap group there also found to be a significant difference for all the time intervals day 1, 2 and 3 (p<0.05).

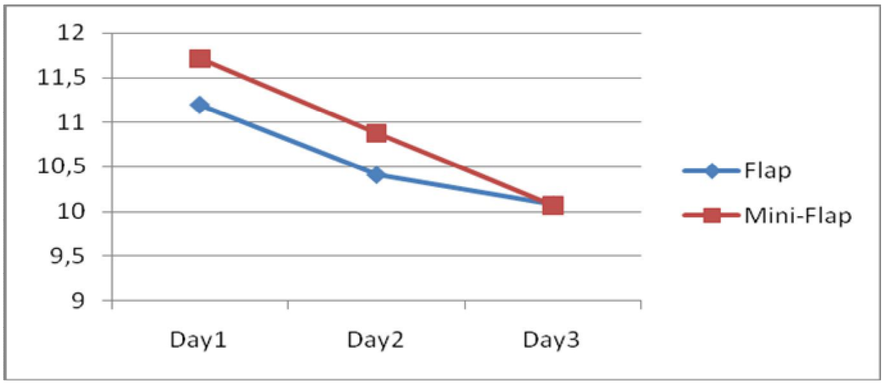


Figure 5: Comparison between F and M.F. group with PA in the laser group

Table 9: Assessment of bone loss on PN radiographs for both flap designs in the irradiated group.

Laser	Day	Flap (n=27)	Mini-Flap(n=27)	p	p^F	p^{MF}
PN	1	11,453±0,448 (10,529-12,378)	11,721±0,504 (10,681-12,761)	0,703	-	-
PN	2	10,695±0,450 (9,765-11,625)	10,970±0,507 (9,924-12,016)	0,696	0,000*	0,001*
PN	3	10,369±0,465 (9,409-11,329)	10,437±0,523 (9,357-11,517)	0,925	0,008* 0,000*§	0,000* 0,000*§

p Difference between the Flap and Mini-Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^F Flap group, p^{MF} Mini-Flap Group)
* p < 0.05

There was no significant difference between the flap and the mini-flap group in day 1,2 and 3 (p>0.05). However, there was a significant difference when flap and the mini-flap groups where assessed within the group (p<0.05).

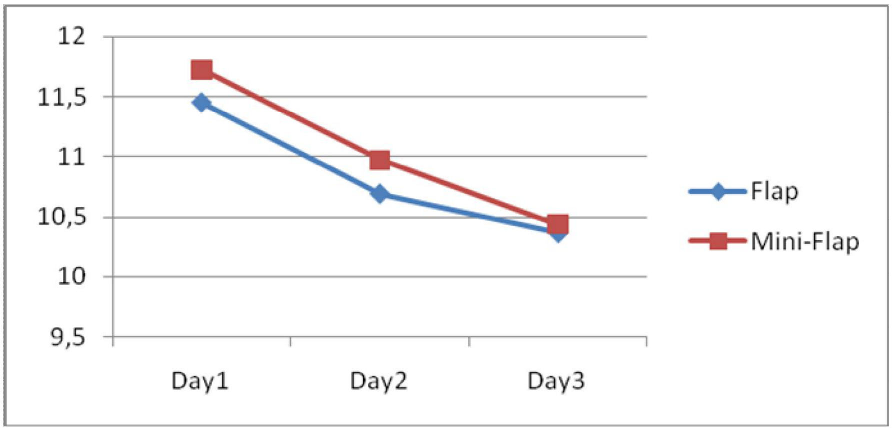


Figure 6: Comparison between F and M.F. group with PN in the laser group

Table 10: Assessment of bone loss on PA radiographs for both flap designs in the non-irradiated group.

No-laser	Day	Flap (n=27)	Mini-Flap (n=27)	p	p^F	p^{MF}
PA	1	10,183±0,496 (9,160-11,206)	11,313±0,557 (10,162-12,463)	0,153	-	-
PA	2	9,376±0,516 (8,310-10,442)	10,671±0,581 (9,472-11,870)	0,118	0,000*	0,004*
PA	3	8,969±0,508 (7,921-10,017)	10,176±0,571 (8,998-11,355)	0,137	0,016* 0,000*§	0,009* 0,000*§

p Difference between the Flap and Mini-Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^F Flap group, p^{MF} Mini-Flap Group)
* $p < 0.05$

There was no significant difference between the flap and mini-flap group in day 1,2 and 3 (p>0,05). However, there was a significant difference when flap and the mini-flap groups where assessed within the group (p<0.05).

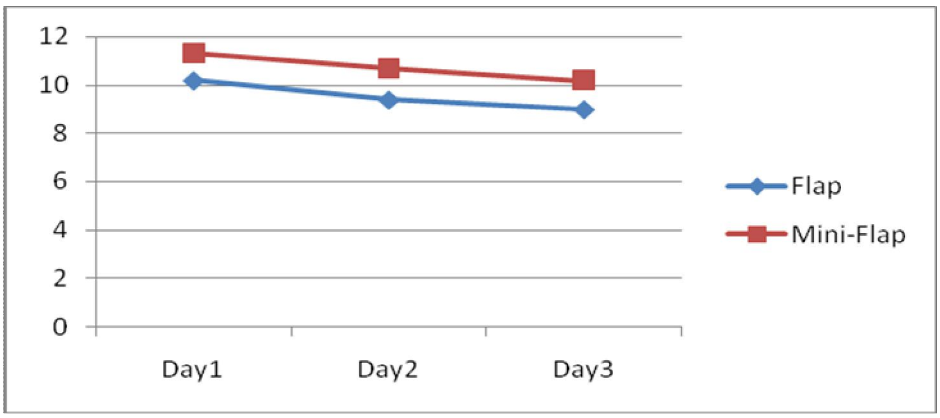


Figure 7: Comparison between F and M.F. group with PA in the non-laser group

Table 11: Assessment of bone loss on PN radiographs for both flap designs in the non-irradiated group.

No-Laser	Day	Flap (n=27)	Mini-Flap (n=27)	p	p^F	p^{MF}
PN	1	10,301±0,479 (9,313-11,289)	11,271±0,538 (10,159-12,382)	0,202	-	-
PN	2	9,521±0,444 (8,603-10,438)	10,574±0,500 (9,542-11,606)	0,138	0,000*	0,001*
PN	3	8,997±0,458 (8,052-9,942)	10,149±0,515 (9,086-11,212)	0,116	0,002* 0,000*§	0,028* 0,000*§

p Difference in between the flap and Mini-Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^F Flap group, p^{MF} Mini-Flap Group)
* p < 0.05

There was no significant difference between the flap and the mini-flap group in day 1, 2 and 3 (p>0.05). However, there was a significant difference when flap and mini-flap groups where assessed within the group (p<0.05).

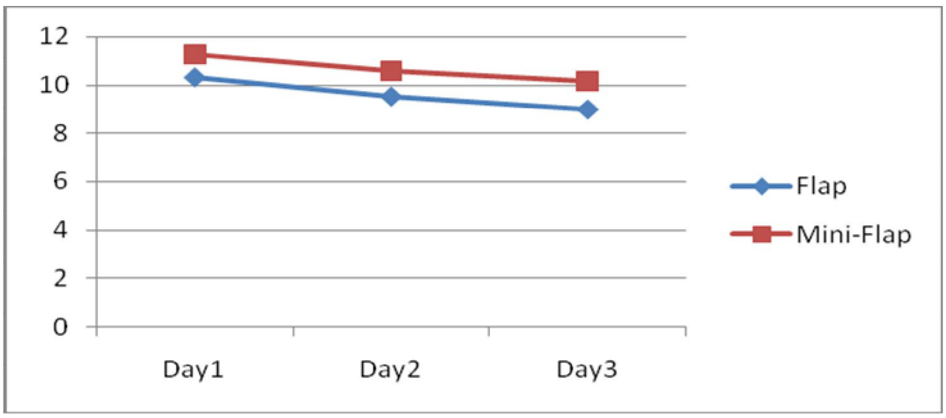


Figure 8: Comparison between F and M.F. group with PN in the non-laser group

5. DISCUSSION

Minimal flap removal in implant surgery may offer advantages over the conventional flap approach. There may be minimized bleeding, decreased operation times, minimized patient discomfort, and possibly less bone resorption around implants. The cumulative success rate for the first two years following mini-flap approach has been reported to be 98.7% [65]. Implants that were placed with conventional flap elevation, the connective tissue between the barrier epithelium and the marginal bone were poorly vascularized[66]. There have been reports that flapless implant surgery is a predictable procedure with high success rates if patients are appropriately selected and an appropriate width of bone is available for implant placement because of better vascularization[44,65,67].

Nevertheless, using conventional flap elevation provides a better visual inspection of the implant site and in turn makes the control of drill direction easier. This technique was considered as the standard procedure in 1999. It is likely that the selection of an appropriate flap approach may have an impact on the soft tissue appearance following implant replacement[68]. Recently, the success rate of flapless implant surgical procedure has been reported to be increased with a proper patient selection[44,65]. It has also been suggested that elimination of the mucoperiosteal flap removal may prevent potential postoperative bone resorption associated with flap elevation[45]. There have been only a few direct comparisons between flap and mini-flap implant surgeries[43]. Implants are placed in either one or two stages[69-71]. The survivals rate of dental implants applied within last 10 years was reported to be 74.1% to 100% when flapless surgery was used[44].

Blanco et al. reported in their study that there was no statically significant difference between the flap and flapless group in the term of bone resorption (1.33 mm/0.82 mm). This difference in bone resorption did not infer a difference in soft tissue recession[72]. In most cases an extended flap is needed to visualize the bone sufficiently in order to avoid perforations of critical anatomic structures. On the other hand, minimizing the surgical flap may have advantages for soft tissue healing and patient comfort[73,74]. Findings of the present study support Blanco et al that there was no significant difference between two different flap design applied in term of bone resorption when PA radiographs (Table 8 and 10) and PN radiographs (Table 9 and 11) were used for the measurement.

When placing dental implants, flap is traditionally elevated to better visualize the implant recipient sites and some of the anatomical landmarks (i.e., foramina, maxillary sinuses) in order to identify them clearly for the better approach and also protection. When a limited amount of bone is available, flap elevation can help implant placement to reduce the risk of bone fenestrations or perforations. However, flap elevation needs suturing and that is related to some degree of morbidity and discomfort[75]. Previous studies have also revealed that flap reflection often results in gingival recession and bone resorption around natural teeth[75,76].

Patients treated with the flapless approach must be carefully selected and they should have sufficient bone volume for implant placement[45]. Flapless implant placement is generally a blind technique; care must be taken when placing the implants due to possibility of cortical bone perforation, both lingual and buccal, especially on the lingual mandible molar area and the anterior maxilla[46]. Potential for contamination of the implant upon placement also increases in this procedure[73]. Panduric et al. concluded the results attained by the computerized densitometric analysis of radiovisiography images during the period of 18 months, that flapless technique in routine clinical usage has got the same result when compared by the two-stage dental implant technique[44,46,75,77,78]. However, it seems like much more time has to be invested in the preoperative planning and all the preparations that are necessary when the transmucosal approach is used compared with implant placement following elevation of mucoperiosteal flaps[79].

Nevertheless, flapless implant surgical procedure offers clinicians the possibility of placing implants in less time, without extensive flap removal with less bleeding and postoperative discomfort[43-45,65,80]. However, there is some concern that the epithelium or connective tissue may be forced into the osteotomy line during the concerned site preparation or implant installation because the flap is not reflected to expose the underlying bone, and is likely interfere with OI[43]. Jeong et al. presented that there is no difference in crestal bone loss between implants placed by the flap procedure and those placed by the mini-flap procedure[43,45]. They also reported that in the mini-flap group no implants failed to osseointegrate, while five implants in the flap group failed to integrate during the healing process. In addition, nine implants in the flap group exhibited bone loss approximately >1.2 mm while no implants in the mini-flap group exhibited that amount of bone loss. The low frequency of both early failure and progressive bone loss in the mini-flap group support the findings of previous studies, affirming the flapless implant surgical procedure as a predictable procedure with a high success rate[43,44,65]. Moreover, Jeong et al claimed that progressive peri-implant bone-level reduction and implant loss were more frequent in the maxilla than in the mandible in both flap and mini-flap procedures during the healing period, but the difference was little and insignificant ($p>0.05$). The demographic comparisons of those treated with the flap procedure and those treated with the mini-flap procedure supports that there were no statistically significant differences between the two groups with respect to patients' age, sex, implant location, or smoking status. Therefore, it is suggested that the mini-flap procedure may even increase the success rate[43]. The present study also revealed that there was no significant difference between the two different flap groups with respect to age and gender

(Table 2). In addition, bone resorption was found to be less in the mini-flap group, however, results were not significant ($p>0.05$) (Table 8-11).

Higher bone loss rates with the widely mobilized flap sites were related to the fact that whenever a papilla is detached from bone, the interdental bone in proximity to the adjacent tooth is denuded from the periosteum. This can affect the nutrition of the bone and papillae, depending on duration of surgery, and may result in an individually unpredictable degree of resorption of the interproximal crestal bone. According to Gomez-Roman, the use of a limited flap design is recommended to minimize interproximal crestal bone loss and possible loss of the papillae. This approach conserves the papillae during implant placement. The limited flap design is also advantageous if the two mucosal wound edges are brought together during closure[42,81].

Implant placement without mucoperiosteal flap elevation has not only been recognized as a successful procedure, but also as a procedure that reduces postoperative swelling and patient discomfort. Soft tissue reflection to allow the implant placement is generally associated with some degree of bone resorption. This phenomenon may be caused by the micro-architecture of the crestal bone, which is not well vascularized. When soft tissues are elevated the blood supply to the bone is interrupted, predisposing the crestal bone. In contrary, it was also reported that mucoperioateal flap elevation may stimulate a wound healing process along with the angiogenesis of the vascular plexus and at the same time the resorption of the alveolar bone[42,82-84]. Our findings determined that resorption around dental implants were less in the mini-flap group than the conventional flap group but insignificant ($p>0.05$) (Figure 5-8).

You and co-workers showed in their radiographic evaluations that there was a small amount of bone loss during the healing process in the flap group, whereas there was no visible bone loss in the flapless group. They reported that the average bone loss was 0.2±0.3 mm in the flap group and 0.0 mm in the flapless group, and that the difference was statistically significant[85] ($p<0.05$). Our study revealed a non-significant increase in the average bone loss of the flap group than the mini-flap group (Table 9 and 10).

The flapless implant procedure requires an access incision, which eliminates less attached gingiva and may compromise soft tissue esthetics. Potential for contamination of the implant upon placement also increases in this procedure. Alternative techniques that transfer a presurgical plan to the clinical setting have been suggested to be advantageous in flapless implant procedures[47,73,80], but these techniques are still inherently blind and are based on drilling through a preformed drill guide. These drill guides do not permit intraoperative modification of the plan, and their accuracy cannot be verified during surgery[80]. The mini-flap design we applied was a modification of a flap technique which eliminates the removal of muccoperiosteal flap on the crestal bone where the implants were placed. Therefore, this modified mini-flap technique could allow better vision and better drilling to surgeon, and offers less discomfort and postoperative pain to patient.

Jeung et al. reported in their mini-incision flap design that there may be one major limitation of the flapless mini-insicion surgery is the lack of visibility of hard tissue contours during the procedure. This increases the risk that implant threads will be exposed and that no bone defects can be corrected during implant insertion[86]. The mini-flap technique used in this study, did not give the access to trash the crestal bone in any reason because of the limited flap removal.

Moreover, in the navigated flapless technique there was no possibility to smooth sharp bony edges at the alveolar crest either as shifting could lead to more deviations at the coronal end. In addition, there was one more limitation of this technique which is the cost of CT images and the navigation technology. In addition, this technique may cause a major surgical problem in cases where the ridge is irregular or a knife edge exists[87].

This study supports Gomez-Roman and Cannizzaro's study that there was an insignificant higher bone resorption in flap technique compared to the mini-flap technique[81,88]. In addition, Becker et al. reported that elimination of the mucoperiosteal flap may prevent potential postoperative bone resorption associated with flap elevation[10]. However, Jeong et al presented in their study that there was no statistically significant difference between both of the flap techniques in term of bone resorption. They reported that five implants failed to integrate in the flap group while no implants failed to osseointegrate in the mini-flap group. Similary, in the present study five implants failed to integrate in the flap group and only one implant failed to integrate in the mini-flap group[43]. Therefore, results supported the findings of Jeong et al that implants in the mini-flap group revealed a less implant failure than the flap group. Furthermore, we also examined the correlation between patient's age and the flap techniques related to implant failure and found a significant difference for implant failure in the conventional flap group (Table 3).

When placing dental implants, a flap is elevated to better visualize the bone site that will receive the implants. Flap elevation ensures that some anatomical landmarks, e.g. foramina, lingual undercuts or maxillary sinuses, are clearly identified and protected. In cases where there is a limited amount of available bone, raising a flap can facilitate implant placement to maximize bony contact, minimizing the risk of bone fenestrations or perforations. Therefore, when the mini-flap approach is the choice, it requires a certain degree of clinical experience along with sufficient bone quantity where implants will be placed. Additionally, properly designed randomized controlled clinical trials are still needed to confirm these preliminary results[88]. Our study confirmed that detailed clinical examination and conventional radiographs such as PA and PN were enough to make the choice of mini-flap approach.

The accuracy of linear radiographic measurements in determining changes in post-treatment bone levels following regenerative therapy has been reported by Tonetti and co-workers. They found that linear measurements underestimated bone fill by 1.2mm[89]. Toback et al found mild improvement by underestimating bone fill by 0.96mm[49]. Both studies agree that there is excessive variability of linear radiographic measurements in identifying clinical bone fill. Both studies found that the differences between clinical findings and linear radiographic measurements were statistically significant[49,89]. Moreover, several authors have reported that PN radiographs are useful for following interforaminal implants in the edentulous mandible while others found PN radiographs are problematic because of the superimposition of the vertebral column on the anterior region of the maxillary and mandibular jaws and the resultant variable distortions[19,90-95].

PN radiographs have sufficient accuracy to measure the vertical dimension when a patient is correctly positioned[53,96,97]. It is an alternative radiologic procedure. Because of its standardized projection in the vertical plane, it is well suited for vertical measurements. Because of its complex rotational scanning mechanism, modern PN radiographs have been found to offer high image quality and accuracy. The inherent symmetric imaging error in the vertical plane can be corrected by the magnification factor. This can be computed reliably by comparing the radiologic implant length with the actual implant length relative to a reference point. Schmelzeisen and coworkers found that the implant-abutment interface was the most reliable reference point. PN radiographs may be superior to PA films in that they produce readable images of the maxillary and mandibular jaws and can be used even in patients with limited mouth opening. But, they provide 2-dimensional views, which tend to be out of focus because of the superimposition of the vertebral column on the anterior region, are distorted geometrically, and magnify the structures imaged. These distortions have been reported to interfere with the evaluation of peri-implant bone loss[90]. It gives a less detailed picture than PA radiographs[17,50,56,98-101]. Janson and associates found that the radiologic bone loss seen on PN was similar by the actual clinical loss in about 60% of the cases[101].

PA radiographs have a higher resolution but are more time consuming to obtain[50]. Sivasriyanond and Manson-Hing[102] reported that the imaging accuracy of PA radiographs was 10 line pairs/mm (resolution 0.1 mm), versus 5 line pairs/mm (resolution 0.2 mm) for PN radiographs. However, the technologic superiority of PA radiographs versus rotational PN radiographs may be irrelevant for longitudinal follow-ups, because Bragger and associates showed that alterations in marginal bone height of less than 0.2 mm were not reliably evaluable during follow-up[18,103].

Nair et al compared conventional film images with both unenhanced and enhanced CCD images with respect to assessment of the alveolar crestal bone. They found no statistically significant differences in the diagnostic efficacy between the different image modalities[104,105]. Hildebolt et al compared original radiographs, unprocessed digital images, and Wallis-enhanced digital images for alveolar bone loss measurement and vertical defect diagnosis. They found that the enhanced images improved the measurement of the alveolar bone loss and there were no differences between the imaging modalities for the diagnosis of vertical defects[106]. According to Benn, dental radiographs have numerous shortcomings for measuring alveolar bone changes around teeth, bone loss differences less than 1mm are not likely measurement errors. Moreover, the achievement of valid measurements of bone loss less than

0.2 mm around osseointegrated implants has been found difficult, even with the use of optimum techniques[107,108]. In our study, it was also a fact that measuring the bone loss around implants less than 1mm was difficult, especially when the measurements were done in the premolar region on PN radiographs.

PA and PN radiography are associated with low radiation doses. The radiation dose from a conventional tomography is comparable to PA while CT is associated with a high radiation exposure to the patient[57,109-111]. Radiographic mandibular bone density on PN radiographs gives a weak but significant relation to alveolar bone level, with more periodontal break-down for less dense alveolar bone. There was a weak but significant relationship between mandibular radiographic bone density and the loss of alveolar bone level in the premolar area of the lower jaw[112]. Most of the implants that were placed in the present study were in the mandibular molar area. It is observed that PN radiographs were more effective in the mandibular molar area than the mandibular premolar area due to the angulations of PN which cause superimposition of the images.

Zechner[90] and coworkers reported that PN radiographs are more useful in edentulous mandible due to difficulty of the PA radiographs to be taken in that area, that is the reason why no edentulous patients were enrolled to the present study. In contrary to our results Anil and Flanagan et al reported that PN radiographs gives a less detailed picture than PA radiographs[57,58]. Sivasriyanond and Manson-Hing also reported that the imaging accuracy of PA radiographs are more than the PN radiographs in about resolution of 0,1 mm[102]. However, Bragger and associates found that superiority of PA radiographs versus PN radiographs may be irrelevant for longitudinal follow-ups due to that alterations in marginal bone height of less than 0.2 mm were not reliably evaluable during follow-up[18]. Hildebolt et al found that there were no differences between the imaging modalities for the diagnosis of vertical defects between unprocessed digital images and digital images for alveolar bone loss measurements either [106].

Lasers have become widely and increasingly used in medicine and dentistry since the development of ruby laser in the 1960s. A number of different lasers light, including HeNe, GaAlAs argon and others have been used in different doses and treatment schedules[13]. LLLT has enhanced the treatment of a variety of morbid states including alleviating pain, healing wounds, and resolving nerve injuries. Recent research has reported that LLLT could stimulate osseteogenesis in the surrounding tissue and OI[13,26].

Khadra et al. reported in their study that histomorphometrical evaluation and energy-dispresive x-ray microanalysis demonstrated that LLLT had a positive effect on the functional attachment of titanium implants to bone. The irradiated implants showed a better bone bonding than non-irradiated controls[13]. Ozawa et al. reported that LLLI has a positive effect on calcification as well[113]. Moreover, Saito & Shimizu concluded that low-power GaAlAs diode laser irradiation significantly stimulated bone regeneration in the midpalatal suture during rapid palatal expansion[114]. This study confirms the results of previous studies stating that LLLI could have positive impact on OI of dental implants[13,166,115] (Table 4-7) (Figure 1-4).

Pereira et al. evaluated the influence of GaAlAs diode laser with a wavelength of 780nm and a fluency of 7.5 J/cm² for 10 seconds in each point on bone healing around titanium implants placed in rabbit tibiae. BIC was significantly increased in the laser treated group in 3rd and 6th weeks. However, BIC was not significant in between 3 to 6 weeks. Considering bone area within the threads, no significant difference was found for treatment with or without laser application. They concluded that LLLT did not affect the area of bone formed within the threads, but it may improve BIC of titanium implants inserted in rabbit tibiae[62]. In our study, GAAlAs diode laser was used with a wavelength of 830 nm and output power of 94 mw, and a fluency of 3.0 J/cm^2 for 39 seconds in each of the four sessions. Results determined a significant difference only in the irradiated implants placed with the flap design on the measurements of PN radiographs (Table 6).

Freitas et al measured the effects of He-Ne laser radiation on bone recovery using light and electron microscopes. Differences in the recoveries have been observed between the irradiated and the unirradiated specimens. Daily doses of 31.5 and 94.7 J/cm² over a 7 and 14 day period of irradiation caused progressive and faster bone consolidation compared to the controls, being greater for the 94.7cm². When a LLL was used (1mW, 633nm), the results demonstrated that the photo-biological processes, unrelated to thermal effects probably constitute the basic mechanisms involved in the recovery of the injured tissue[116].

Dörtbudak et al examined the effects of LLLI on osteocytes and bone resorption at bony implant sites. The percentage of viable osteocytes was determined to be significantly higher in the irradiated vs. the non-irradiated group[117]. Luger et al. found that, while more callus was formed in the non-irradiated group, the bone was weaker than in the irradiated group. This was explained by a more fibrocartilaginous and less ossified callus in the non-irradiated group and an immediate onset of ossification with faster callus resorption in the irradiated group[118].

Jaske et al aimed in their experimental study to evaluate if LLLT enhances bone regeneration and OI of dental implants in a sinus graft model. The implant sites were irradiated intraoperatively and three times during the first postoperative week with a diode laser (75mW, 680 nm). The overall energy density per irradiation was 3-4 /cm². They confirmed previous studies which states that LLLI could have positive impact on OI of dental implants[61]. Guzzardella and co-workers inserted ceramic implants in distal femurs of 12 rabbits. They used a GaAlAs laser with a wave length of 780 nm and the overall applied energy density on the test site was 300 J/cm². The histomorphometric analysis indicated a significantly higher bone microhardness due to osteocyte viability in the LLLT group compared with the control group ($p<0.01$). Furthermore, they revealed a significantly higher affinity index ($P<0.0005$) at a HA-bone interface of inserted ceramic implants in the LLL irradiated group. As a consequence, they suggested that postoperative LLLI enhances the bone-implant interface[115]. On the contrary, Payer et al. showed no significant clinical benefit of an intra- and postoperative LLLT compared with a control group when using a laser energy density of 3-4 J/cm² [119]. Laser energy density of 3 J/cm^2 was also used in the present study and found to be a significant difference only in the conventional flap group when measurements were done on PN radiographs (p<0.0.5).

Lopes et al applied to nine rabbits a LLLT in four points, 830 nm, at 48 hrs intervals (21.5 J/cm²) during 15 days, resulting in an 85 J/cm² treatment dose. The results indicated that LLLT increased the concentration of calcium hydroxyapatite (CHA). Increased amount of CHA in bone is indicative of a more resistant bone. The results evidenced a reduction of about 30% in the healing time of the bone. It is possible to reduce the loading time of implants in the mandible of humans from ‘4 months’ to approximately ‘2 months and 24 days’, and in the maxillae, from 6 months to 4 months and 6 days[120].

6. CONCLUSION

In the present study we examined the effectiveness of GaAlAs diode lasers on dental implants OI and the possibility of reducing bone loss. We also did a comparison between normal conventional flap and mini-flap designs to evaluate the success rate between both flap techniques and the relation between them and bone loss around the dental implants with the measurements done on PA and PN radiographs. The results were as follows;

1. There was no significant difference between both of the flap groups and gender and both of the flap groups and age.

2. In implant failure there was a significant difference between the normal flap group and age ($p<0.05$).

3. PA radiographs revealed no significant difference in the flap group between the irradiated and non-irradiated group ($p>0.05$). However, it found to be more bone loss in the non-irradiated group on PA radiographs.

4. The PN radiographs in the flap group indicated a significant difference between the irradiated and non-irradiated group ($p<0.05$). The bone loss in the irradiated group was less.

5. In the mini-flap group PA and PN radiographs determined no significant difference between the irradiated and non-irradiated group ($p>0.05$). There was more bone loss in the non-irradiated group on PA and PN radiographs.

6. PA and PN radiographs revealed no significant difference between the flap and mini-flap design in the irradiated group (p>0.0.5). However, bone loss in the mini-flap group was less.

7. PA and PN radiographs revealed no significant difference between the flap and mini-flap design in the non-irradiated group (p>0.0.5). However, bone loss in the mini-flap group was less.

8. A total of six implants failed to osseointigrate, three of them were from the irradiated group while the other three of them were from the non-irradiated group.

According to the results obtained in our study, we advice to increase the number of irradiation sessions, and decrease the duration between sessions.

In this study both of the flap groups and the laser groups did not show any significant differences in the bone resorption according to the evaluations done on PA and PN radiographs. Bone loss in the non-irradiated group was a little higher than the irradiated group. The resorption amount around the titanium implants in the mini-flap design showed less bone loss than the normal flap technique.

The conclusion was that PN radiographs can be used alone, supplemented when necessary by PA radiographs in cases where the PN radiograph is not of sufficient quality.

According to the PA and PN radiographs the results suggest that LLLT may be a promising treatment modality for accelerating implant healing in bone by increasing the number of sessions and reduce time between application sessions.

Although we did not find any significant difference between mini-flap and flap designs, we observed more implant failure and bone loss in the conventional flap group. Therefore, mini-flap technique should be the choice for implant application with a proper patient selection.

7. SUMMARY

The aim of this study was to determine the ability of two forms of radiographic analysis PA and digital PN to assess post-surgical resorption in the bone-level after applying LLLT and using different flap designs. 27 patients were recruited in this study, all of the patients were free from any systematic diseases, agreed to come to all follow-up controls acquired. Total of 54 implants were bilaterally inserted to 27 patients. For all the patients GaAlAs diode laser with a wavelength of 830nm and output power of 94 mw, and a fluency of 3.0 J/cm^2 was employed for at one point perpendiculary to the selected implants for 39 seconds in total of four sessions. First, it was applied introperatively, the second was after the suturing immediately, and the last two were at day five and seven. LLLT was applied to one side and the other side was the control group. A total of 15 patients underwent to normal flap surgical technique, while the rest of the 12 patients underwent to mini-flap technique.

The radiographs were taken directly after the implants were inserted, and then at the end of the 1st month. The third radiographs were taken at the end of 3rd month for the implants in the mandible and at the end of 4th month for implants inserted in the upper jaw. To try and keep the same angulation in the PA radiographs, an anterior and posterior film holders were used with an individual impression taken for each patient before the surgery. All the PA and PN radiographs were converted using ScionImage program convertor and then microanalayzed.

The irradiated group revealed less bone resorption than the non-irradiated group in both radiographs, but the difference was not significant. There was a significant difference ($p<0.05$) in the bone level resorption around dental implants which was inserted with the normal flap removal between the irradiated and the non-irradiated groups on the PN

analysis. There was no significant difference in the irradiated flap group in at day 2-3 on the PA radiographs ($p>0.05$). While, there was a significant difference at the rest of the time intervals within the same group ($p<0.05$).

In comparison between the two flap techniques, the mini-flap group does also revealed showed less bone loss than the flap group, however there was no significant difference observed. There were six implants which failed to osseointegrate after the healing period, five of them were from the normal flap group and the last one of them was from the mini-flap group. Three out of the six failed implants were from the irradiated group, while the other failed three implants were from the non-irradiated group.

8. ÖZET

‘Dental İmplantlar Çevresindeki Sert Doku Densitesinin Konvensiyonel Radyograflar ile İncelenmesi’

İmplant sözcüğü latince, ‘in=içerisine, içerisinde´ ve ‘planto=ekme, dikme veya yerleştirme´ anlamına gelen sözcüklerin bileşiminden oluşmuştur. Anlam olarak ise bir fonksiyon elde etme amacı ile, uygun bir yere yerleştirilen organik veya inorganik cisme verilen isimdir ve fransızcadan diğer dillere geçmiştir[2].

Vücudun kayba uğrayan herhangi bir kısmını suni olarak tamamlayan, iyileşmesine yardımcı olan ve doku içerisine yerleştirilen suni yapılara ‘implant protezi´ adı verilmektedir[2,14].

Diş hekimliğinin temel amacı, hastada doğal konturu, rahatlığı, estetiği, sağlığı ve fonksiyonu sağlamaktır. Modern diş hekimliği, ağız ve çeneler bölgesindeki atrofi, hastalık ve yaralanma miktarına bakmaksızın bireye kaybettiği oral fonksiyonları en üst düzeyde iade etmeyi hedeflemektedir. Diş kayıpları çoğunlukla, ağız hastalıkları veya kafa-yüz kompleksinde meydana gelen yaralanmalar sonrasında sık karşılaşılan bir bulgudur. Dental implantlar, oral ve maksillofasiyal rekonstrüksiyonda Kabul görmüş tedavi seçenekleri olup tam ark rekonstrüksiyonlarında tek veya çok sayıdaki diş eksikliğini gidermek için yapılan protezlerde yaygın olarak kullanılmaktadır. Branemark’ın 1953 yılında titanyumu kullanmaya başlaması ve osseointegrasyon (Oİ) kavramının ortaya konmasıyla diş hekimliğinde implant alanında önemli ilerlemeler kaydedilmiştir[6].

Modern implantoloji yüz yılı aşkın bir süredir devamlı gelişme kaydetmektedir. Kemik içi implantlar, gerek tek gerekse çok sayıda diş eksikliğinde, konvansiyonel protezler ile tatminkar sonuçların elde edilemeyeceği vakalarda sıklıkla kullanılır. Yerleştirildikten sonra, implant ile çevresindeki kemik arasında Oİ olarak bilinen proses meydana gelir. İmplantın, uygulama sırasında elde edilen ilk stabilitesi ve implantasyondan bir sure sonra oluşan Oİ, implantın başarısında rol alan iki önemli faktördür[18,23,24].

Oİ, bir implantın başarısını veya başarısızlığını tanımlayan bir dizi kriteri belirleyen önemli bir kavram olarak, ilk defa 1960'lı yılların ortasında implantoloji dünyasına sunulmuştur. İmplant ve alveolar kemik arasında yeterli düzeyde Oİ oluşup oluşmadığına karar vermek veya mevcut Oİ' nu değerlendirmek bu konuyla ilgilenen hekimlerin karşısına önemli bir problem olarak çıkmaktadır[18,23,24].

Oİ, ilk kez Branemark tarafından ışık mikroskobu seviyesinde implant yüzeyi ile yaşayan kemik arasındaki temas olarak tanımlanmış olup daha sonra Oİ terimi implantoloji alanında sadece mikroskobik değil aynı zamanda klinik bir durumu da tanımlayan bir terim halini almıştır.

Oİ, 'canlı kemik ile yük taşıyan implant yüzeyi arasındaki direkt 'fonksiyonel ve yapısal birleşme´ olarak tanımlanmaktadır. İmplantın kemik içine yerleştirilmesi ile titanium gövdenin çevresindeki travmatize kemiğin nekroz ve rezorbsiyonu ile birlikte implanta komşu bölgede yeni kemik oluşumuyla karakterize bir dizi iyileşme olayı gözlenmektedir[23-29].

İmplantın yerleştirilmesi sırasında implant ve kemik arasında kontak sağlanması ile elde edilen stabilite primer stabilite olarak adlandırılır. Primer implant stabilitesi, başarılı bir Oİ'un sağlanması için bir ön koşul olarak kabul edilmektedir. Primer stabilite, mekanik bir parametre olup, implant cerrahisinden hemen sonra elde edilir ve primer kemik kontağının miktarına bağlı olarak değişiklik gösterebilir. Primer stabilite, aşağıdaki faktörlere bağlı olarakta değişebilir[34-37];

- Kemiğin kalite ve kantitesi
- İmplantın boyu

- İmplantın çapı
- İmplantın dizaynı
- İmplantın üzerindeki yivlerin konfigürasyonu
- İmplantın yüzeyinin mikromorfolojisi
- İmplant yatağının hazırlanmasında kullanılan teknik

İmplant cerrahisindeki pek çok teknik genellikle alveolar kret tepesinden geçen insizyon ve mukozanın kaldırılması ile başlar. İmplantın yerleştirilmesinden sonra mukoza sütüre edilir. İyileşme periyodundan sonra mukoza tekrar açılır ve transmukozal komponentler yerleştirilir[42].

Flepsiz cerrahi tekniği sadece implantın yerleştirileceği kadar yumuşak dokunun kaldırılması veya yumuşak dokuda kemiğe doğrudan yapılan kemik içerisine frezler yardımı ile implantın yerleştirileceği yerin hazırlanması işlemlerini içerir. Flepsiz cerrahi teknik ile minimal kanama ve ödem sağlanır[44-46]. Avantajlarına rağmen, flepsiz cerrahi tekniği alveol kretteki konturlar ve açılanmaların değerlendirilebilmesi zorluğundan dolayı, ayrıca fenestrasyona neden olabilmesi veya komşu dişe zarar verebildiğinden dolayı kör bir teknik olarak yorumlanmıştır. Bundan dolayı bu tekniğin, madde kaybı olmayan geniş kretlerde kullanılması önerilmektedir. Bir başka insizyon tekniği ise mini-flep tekniğidir. Bu teknik ise, mukoperiostal flebin çok az kaldırılarak implantın yerleştirildiği minimal invaziv cerrahi metodlardan biridir. Bu teknik sayesinde işlem süresinin kısalması, minimal kanama, postoperatif dönemin hasta açısından daha rahat geçmesi, erken yükleme olasılığının artması ve daha kısa sürede implant destekli protezin yapılması gibi avantajları bulunmaktadır. Dental implantolojide kullanılan iki aşamalı cerrahi teknikte tam kalınlık flebin kaldırılmasına bağlı olarak marjinal kemik kaybının artması ve yumuşak doku çekilmesi gibi komplikasyonlar sıklıkla görülebilmektedir. Mini-flep tekniği ile bu komplikasyonlar minimale indirilmektedir. Flep kaldırılmadığı taktirde, postoperative şikayetler azalmakta ve muhtemel skar formasyonu oluşumu ihtimali ortadan kalkmaktadır. Periostun lingual ve bukkal kemik yüzeylerinde kaldırılmadan bırakılması daha iyi beslenmeyi sağlayıp rezorbsiyon miktarının minimal düzeyde kalmasına neden olmaktadır[43].

Radyografik analizler non-invaziv şekilde çoğu zaman tedavi seçeneklerinin belirlenmesinde rol almışlardır. Genellikle temel radyografiler (PA veya PN) implantların yerleştirileceği alanları değerlendirilmesinde kullanılmaktadır. PN radyografiler, implant bölgeleri için tahsis edilmeyen patolojik değişikler veya çürükler ortaya çıkarabilirler. PN radyografiler, anatomik komşuluklar, maksiller sinüs, burun tabanı veya mandibular kanal ile komşuluklar ve implantın vertikal boyutunun saptanması gibi önemli durumların saptanmasında yardımcı olabilmektedir. Bununla birlikte periimplant bölgenin değerlendirilebilmesi ve magnifikasyon derecesinin belli oluşu gibi birçok başka avantajlarıda bulunmaktadır[49-52].

PA radyografiler altın standart olarak tanımlanmaktadır. RVG'ler ile kıyaslandığında radyasyon dozunun daha fazla olmasına rağmen molar dişler bölgesinden alınan PA'larda radyasyon dozunun PN'lere göre beş kat daha az olduğu saptanmıştır. Sıklıkla diş çürükleri ve özellikle arayüz çürküklerinin saptanmasında, meziodistal boyut ve periimplant bölgesinin net bir şekilde görüntülenmesinde kullanılmaktadır. Diğer avantajları sıralanacak olursa[16,55],

- Kolay çekilebilmesi
- Ucuz olması
- Yüksek kontrast
- Düşük radyasyon
- İmplanta komşu dişlerin köklerini net göstermesi

Son yıllarda düşük düzeyli lazerin (DDL) kullanımı ile ilgili yapılan çalışmalar artmaktadır. Çalışmaların bir kısmı DDL'in postoperatif komplikasyonları en aza indirgemedeki etkinliğini araştırırken, bir kısmı da bu etkinin mekanizmasını araştırmaya yönelik yapılmaktadır. DDL'ler ilk kez 1960'larda tanımlanmış olmasına rağmen, özellikle son 10 yılda kullanımlarında dikkat çekici bir artış olmuştur.

Modern diş hekimliğinde yüksek güçteki cerrahi lazerler birçok oral patolojinin tedavisinde 30 yılı aşkın süredir kullanılmaktadır. Yaygın olarak kullanılan ve iyi bilinen yüksek güçteki cerrahi lazerlerin yanı sıra cerrahi lazerlere ek olarak daha az bilinen ve biyostimülasyon ile biyomodülasyon özelliklerinden yararlanılan düşük güçte lazer tipleri de bulunmaktadır. Yüksek enerjili lazerler dokularda kesme işlemini gerçekleştirmek amacı ile kullanılırken, düşük enerjili lazerler karşılaştıkları hücreye az miktarda enerji yükleyerek, hücrede minör değişikler oluşturmak amacıyla tasarlanmışlardır.

Düşük güçteki lazerler[12];

- Galyum aliminyum arsenid diyot (GaAlAs)
- Helyum neon (He-Ne)
- Galyum arsenid diyot (GaAs)

Bu çalışmada kullanılan GaAlAs lazerlerde aktif madde olarak Galyum aliminyum arsenid maddesi kullanılır. Diyot lazer olarak da tanımlanmaktadırlar. Dalga boyu 830-904 nm'dir. Nabızsal şekilde devamlı ışın yayarlar, dolaylı penetrasyon 5 cm'lik alana kadar yayılabilir. Yüksek doku penetrasyon lazeri olarak da bilinir. Dokulara rahat penetre olup, oral mukoza ve kemiğin 4-8 mm altında seyreden sinir dokusuna kadar ulaşabilir. Yüksek penetasyon özelliğinden dolayı GaAlAs lazer, trigeminal sinir parestezisi tedavisinde de kullanılmaktadır. Lezyona temas ettirmeden yüzeye uygulanması önerilmektedir.

He-Ne lazerler: Aktif madde olarak He-Ne gazı kullanır. %85 helyum, %15 neon gazından oluşurlar. Dalga boyu 633-655 nm olan He-Ne lazer, yaygın olarak kullanılan, ucuz, emniyetli ve pratik bir lazerdir.

Keikli veya devamlı uygulama yapılabilir. Işın kaynağına sürekli bakıldığında gözde harabiyet oluşturma potansiyeline sahiptir. Yüksek dağılım ve düşük absorsiyonda geniş bir doku kitlesine etki etmektedir. Bu nedenle transkutan ışınlama tedavileri için en uygun lazer tipidir. Epitel büyümeyi ve periferal sinir sistemi iyileşmesini indüklediği bildirilmiştir. Yaralı dokuya uygulandığında kollajen ve ribonükleik ait sentezinde ve kan desteğinde artışa neden olarak iyileşmeyi hızlandırdığı düşünülmektedir.

GaAs lazerler: 904 nm dalga boyunda kullanılır. Su ve deri pigmentleri tarafından absorbsiyonunun düşük olması nedeni ile subkutanöz dokulara derin penetrasyona izin veren bir lazer çeşididir.

DDL, düşük miktarda enerjiye sahip ışın kaynağından köken alan atermik fototerapiyi anlatmaktadır. Bu ışın yaşayan hücreyle karşılaştığında hücreye az miktarda enerji verir. Bu enerji yüzey ısısında çok az miktarda değişiklik yaparak, hücrede bir takım minör değişiklere neden olabilmektedir.

DDL terapisinin etkinliğini belirleyen faktörler:

- Dalga boyu
- Polarizasyon
- Güç yoğunluğu
- Enerji yoğunluğu
- Işınlanma süresi
- Uygulanan seansların aralığı
- Işınlama tarifesi

Bu parametrelerin hepsinin önemli rolleri olmasına karşın bazılarının daha da hassas rolleri bulunmaktadır. İki seans arası geçen zaman, olması gerekenden uzun olursa yetersiz ve etkisiz enerji absorbsiyonuna neden olabilir. Uygulanan toplam enerji miktarı, lazerin gücü ve ışınlama süresine bağlı olduğundan; ışınlama süresi de lazer terapisinin etkin olabilmesi için önemli bir faktördür. Lazer ışının çarptığı molekülde höcresel süreçte değişiklik olabilmesi için gereken süreden daha az uygulanan DDL etkisiz olabilir. Güç yoğunluğu W/cm^2 ile, lazer enerjisi joule ile, eneji yoğunluğu da J/cm^2 ile ifade edilmektedir. Bunların dışında DDl'in etkisis dokulara penetre olmasına ve doku sıvısına da bağlıdır. Enerji, sıvı konsantrasyonunun en yüksek olduğu yerde absorbe edildiğinden, iltihaplı ve ödemli dokuda kolaylıkla absorbe olmaktadır. Bu enerji de iyileşme süreci gibi birçok biyolojik reaksiyonu stimule etmektedir[12]. Lazerin penetrasyonu ilk olarak deri veya oral mukozanın özelliklerine bağlıdır. Bu özellikler epitelin tipi ve kalınlığı, yansıtma özelliği, melanin içeriği ve submukozanın vazkülarizasyonudur. Oral kavitenin bu özellikleri henüz incelenmemiştir. İkinci olarak, lazer ışının hedef organa ulaşabilme yeteneği önemlidir. Üçüncü olarak da hedefin ışına duyarlılığı önemlidir[12].

Bu çalışmada toplam 27 hasta yer almıştır. Bütün hastalarda ne sistemik hastalaığı ne de ilaç kullanıldığı bildirilmiştir. Yaşları 17-68 arasında toplam 27 hasta (20 bayan, 7 erkek) Her hastaya iki adet olmak üzere toplam 54 adet bilateral implant yerleştirilmiştir. Hastalar 3-4 ay Oİ süresini tamalamışlardır. İmplantlar bilateral olarak farklı taraflara yerleştirilip, bir tarafta GaAlAs diode lazer her seansta 830nm ve çıkış gücü 94 mw, ve 3 J/cm^2 39 sn olmak üzere toplam dört kez uygulanırken diğer taraf kontrol grubu olarak değerlendirilmiş ve lazer uygulanmamıştır. Lazer uygulaması, intraoperatif, sütürden hemen sonra, 5. ve 7. günlerde olmak üzere aynı tarafa toplam dört kez uygulanmıştır. Toplam 27 hastadan 15'ine normal flep prosedürü uygulanırken kalan 12 hastaya mini-flep tekniği uygulanmıştır.

Çalışma Temmuz 2008 ile Eylül 2009 tarihleri arasında devam etmiştir. Çalışmaya başlamadan önce etik kurulu onayı alımıştır. Çalışmaya katılan bireyler ayrıntılı olarak bilgilendirilmiş, alınan detayılı anamnez hasta bilgi formuna işlenmiştir. İyileşme başlığı takıldıktan sonra 1 hafta yumuşak doku iyileşmesi için beklenip protez işlemlerine başlanmıştır.

İmplantlar yerleştirilmeden önce introperatif olarak sokete diode laser uygyulanmıştır. İmplantlar 30Ncm tork ile yerleştirilmiştir. İmplantlar iki aşamalı olarak yerleştirildikten flep sonra 4/0 ipek sütür ile kapatıldıktan sonra tekrar lazer ugulanmıştır. Lazer 5. Ve 7. Gün toplam dört kez uygulanmıştır. Her seansta 39 sn sürmüştür.

PA radyograflar için hastalardan ameliyat öncesi özel ölç- hazırlanıp anterior/posterior film tutuculara uyumlanmıştır. Hastalardan 1.gün, 1.ay ve 3./4.aylarda hem PA hem PN radyografiler çekilmiştir. Radyografiler üzerinde mini-flep ve normal flep tekniği ile yerleştirilen implantlar çevresindeki kemik rezorbsiyon miktarlarları ölçülerek elde edilen değerler karşılaştırılmıştır.

İmplant cerrahisinde minimal flep kaldırılması geleneksel flep yaklaşımı ile kıyaslandığında bazı avantajları olduğu gözlenmiştir. Bu yaklaşım ile kanama, operasyon süresi ve hastanın postoperatif ağrı gibi şikayetleri azaltılabilmiş ve aynı zamanda implantlar çevresinde daha az kemik rezorbsiyonunun oluşumu da sağlanabilmiştir. Geleneksel flep kaldırılması ile yerleştirilen implantlarda epitel bariyeri ve marjinal kemik arasındaki bağ dokunun yetersiz bir şekilde vaskülarize olabileceği öne sürülmektedir. Flepsiz implant cerrahisinin ise, hastalar uygun bir şekilde seçildiği ve implant yerleştirilmesi için yeterli genişlikte kemik olduğu durumlarda daha tercih edilebilir bir prosedür olduğu da bazı araştırmacılar tarafından desteklenmektedir.

Geleneksel flep elevasyonunun kullanılması implant bölgesinin görsel olarak daha iyi incelenmesini sağlamakta ve frez yönünün kontrolünü kolaylaştırmaktadır. Son zamanlarda flepsiz implant cerrahisinin, hastalar uygun bir biçimde seçildiğinde ve implant yerleştirmesi için uygun kalınlıkta kemik olduğunda artış gösterebileceği rapor edilmiştir. Ayrıca, mukoperiosteal flepin elimine edilmesinin flep elevasyonu ile ilişkili olan potansiyel postoperatif kemik rezorbsiyonunu önleyebileceği fikride öne sürülmektedir. Flep ve mini-flep implant cerrahileri arasında halen günümüze kadar yapılmış sadece birkaç karşılaştırma mevcuttur.

Dental implantların yerleştirilmesi esnasında implant alıcı sahaları ve anatomik sınırları net bir şekilde belirlemek ve koruyabilmek amacıyla daha iyi ve net bir görüş sağlamak için konvansiyonel flep kaldırma işlemi yapılmaktadır. Bu nedenle, özellikle sınırlı kemik mevcudiyetinde flep elevasyonu kemik fenestrasyonlarının ve perforasyonlarının azaltılması amacıyla implant yerleştirmesinde faydalı olabilmektedir. Bununla birlikte flep elevasyonu sonrasında bölgenin sütüre edilmesini gerektirir ve buda bazı vakalarda hasta rahatsızlğının artması ve morbidite ile ilişkili olabilmektedir. Bunun yanısıra, önceki araştırmalarda flep kaldırılması işleminin doğal dişler etrafında sıklıkla dişeti çekilmesi ve buna bağlı kemik rezorbsiyonlarının görülmesi ile sonuçlanabildiği de rapor edilmiş olmaktadır.

Flepsiz yaklaşımla tedavi edilen hastaların tedavi planlamalarının dikkatli bir şekilde yapılmalı ve implant yerleştirilmesi için yeterli kemik hacminin olduğu öncelikle saptanmalıdır. Flepsiz implant yerleştirmesi genellikle kör bir tekniktir, implant yerleştirilmesi esnasında mandibular molar bölgenin lingual yüzü ve anterior maksilla başta olmak üzere bukkal ve lingual tarafta kortikal kemik perforasyonu olasılığına karşı dikkatli olunmalıdır. Ayrıca bu prosedürde implantın yerleştirme esnasında kontamine olma potansiyelinin artacağıda unutulmamalıdır.

Mukoperiosteal flep elevasyonu olmaksızın implant yerleştirilmesi sadece başarılı bir prosedür olarak bilinmeyip, ayrıca postoperatif şişlik ve hasta rahatsızlığını azaltan bir prosedürdür. İmplant yerleştirilmesini sağlamak için yumuşak dokuların dekole edilmesi bir miktar kemik rezorbsiyonu ile ilişkilidir. Bu fenomen, alveol kemiğin yeterince vaskülarize olmayan mikro yapısı nedeniyle oluşabilmektedir. Yumuşak dokular eleve edildiğinde kemiğin kan desteği azalabilir. Mukoperiosteal flep elevasyonunun vasküler pleksusun anjiyogenezi ve alveoler kemiğin rezorbsiyonu ile birikte yara iyileşme sürecini stimüle ettiği açık bir şekilde ispat edilmiştir. Bunu destekler şekilde implantı çevreleyen kemikte rezorbsiyonun mini-flep grubunda normal flep grubuna göre istatistiksel olarak anlamlı olmasada daha az olduğu tarafımızdan saptanmıştır.

Mini-flep yaklaşımı tercihi daha iyi bir klinik deneyim ve yeterli kemik miktarı gibi birtakım anatomik gerekliliklere ihtiyaç duyabilmektedir. Ek olarak bu ön sonuçları doğrulamak amacıyla uygun bir şekilde dizayn edilmiş randomize kontrollü klinik çalışmalara ihtiyaç vardır. Yapılan bu araştırma, yeterli klinik kontroller ve uygun radyografilerin alınması halinde, kemik fenestrasyonlarının oluşmayacağı ve önceden rapor edilmiş olan kriterlerin mini-flep tekniğini uygulamak için yeterli olduğunu doğrulamaktadır.

Cerrahi işlem için model hazırlanması ve hazırlanan bu sablona göre implant yerleştirilmesi işlemlerinin flepsiz implant cerrahi prosedürlerinde avantajlı olduğu öne sürülmüştür. Ancak bu teknikte sadece önceden oluşturulmuş frez rehberi boyunca frezleme yapılabilmektedir. Bu frez rehberleri yapılmış olan planın intraoperatif olarak modifikasyonuna izin vermemekte, ve bu nedenle operasyon süresince doğruluklarından emin olunamamaktadır. Araştırmamızda tarafımızdan uygulanmış olan mini-flep dizaynı ise implantın yerleştirileceği alveol kemiği üzerindeki mukoperiosteal flepin kaldırılmasını elimine eden flep tekniğinin bir modifikasyonudur. Bu nedenle modifiye edilmiş bu mini-flep tekniği daha iyi bir görüş açısı ve implantın daha uygun şekilde yerleştirilmesine imkan vermekte, hasta rahatsızlığını ve postoperatif ağrıyıda yine konvensiyonel flep tekniklerine göre azaltmaktadır.

Lineer radyografik ölçümlerin rejeneratif tedaviyi takiben tedavi sonrası kemik seviyelerindeki değişikliklerin belirlenmesindeki doğruluğu önceki araştırmalarda rapor edilmiş bulunmaktadır. Birçok yazar PN radyografilerin dişsiz mandibuladaki interforaminal implantların takibinde faydalı olduğunu rapor etmiştir. Ancak, PN radyografilerde vertebral kolonun maksilla ve mandibulanın ön bölgesinde görüntülerinin üst üste gelmesi ve değişken distorsiyonlar nedeniyle şüpheli olduğunu düşünen araştırmacılarda mevcuttur.

PN radyografiler, hasta doğru olarak pozisyonlandırıldığında vertikal boyutun ölçümü için yeterli doğruluğa sahiptir. PN radyografiler maksilla ve mandibulanın okunabilir görüntülerini sağlamaları ve kısıtlı ağız açıklığına sahip bireylerde de kullanılabilmeleri dolayısıyla PA filmlere göre üstün kabul edilmektedir. Fakat, PN radyografiler vertebral kolonun anterior bölge üzerine süperpoze olması nedeniyle odaktan sapmaya eğilimli olan iki boyutlu görüntü verebilmekte ve geometrik olarak distorsiyona uğrayarak görüntülenen yapıların boyutlarında değişikliklere/ magnifikasyona neden olabilmektedir. Bu distorsiyonların peri-implant kemik kaybı ile karıştırılabileceği rapor edilmiştir. Ek olarak, PN radyografilerin PA radyografilere kıyasla daha az detaylı görüntü verebildiğide bilinmektedir.

Alınan radyografilerde hastaya verilen radyasyon dozlarına dikkat edilmeside gerekmektedir. PA ve PN radyografiler düşük radyasyon dozlarına sahiptir. Konvansiyonel tomografi sonrasında maruz kalınan radyasyon dozu ile PA radyografi karşılaştırılabilirken, Bilgisayarlı

Tomografilerde (BT) alınan radyasyon dozu daha yüksektir. PN radygrafideki mandibular kemik yoğunluğu alveoler kemik seviyesi ile ilgili olarak, daha az yoğun alveoler kemik için daha fazla periodontal yıkımı belirtecek şekilde zayıf fakat belirgin bir ilişki sağlar. Özellikle, alt çene premolar bölgede, mandibular kemik yoğunluğu ve alveoler kemik seviyesi kaybı arasında radyografide zayıf fakat belirgin bir ilişki olduğu ve bu nedenle bu bölgedeki implantalar çevresinde oluşan kemik kayıplarının daha iyi ölçülebileceği bildirilmiştir. Bu çalışmada, uygulanmış olan dental implantların çoğunluğu mandibular molar bölgeye yerleştirilmiştir. Alınan PN radyografilerde açılama dolayısıyla, molar bölgedeki kemik densitesinin premolar bölgeye göre daha belirgin olduğu gözlenmiştir.

Lazer uygulamaları ,1960'lı yıllarda Ruby lazerin geliştirilmesinden bu yana tıp ve diş hekimliğinde geniş ölçüde ve giderek artan bir şekilde kullanılmaktadır. HeNe, GaAlAs, argon ve diğerlerini de içeren bir dizi lazer ışığı farklı dozlarda ve tedavi programlarında kullanılmaktadır. DDL terapisi ağrının azaltılması, yaranın iyileştirilmesi ve sinir yaralanmalarını da içeren birçok vakanın tedavisinde gelişme sağlamıştır. Son araştırmalar LLLT'nin çevre dokulardaki osteogenezi ve osseointegrasyonu arttırdığını da rapor etmektedir.

Sonuç olarak bu çalışmada, GaAlAs diyot lazerin dental implant ossoeintegrasyonu ve kemik kaybını azaltma olasılığı üzerindeki etkinliği araştırılmıştır. Ek olarak, farklı flep uygulamaları arasındaki başarı oranı ve bunlar arasındaki ilişkiler ile birlikte uygulanan dental implantlar çevresindeki kemik kayıpları değerlendirilmiştir. Konvensiyonel flep ve mini-flep dizaynları arasında PA ve PN radyograflar üzerinde yapılan ölçümler sonucunda elde edilen sonuçlar:

1. Her iki flep grubunda cinsiyet ve yaş açısından herhangi bir belirgin fark bulunmamıştır.

2. İmplant kaybı açısından konvensiyonel flep dizaynı uygulaması ve hastaların yaşı arasında istatistiksel olarak anlamlı bir ilişki olduğu bulunmuştur ($p<0.05$).

3. PA radyografiler üzerinde yapılan ölçümlerde, flep grubundaki lazer tedavisi uygulanmış ve uygulanmamış gruplarda belirgin bir farklılık olmadığı saptanmıştır ($p>0.05$). Ancak, lazer tedavisi uygulanmamış olan grupta diğerine göre anlamlı olmayan/daha fazla miktarda kemik kaybı olduğu saptanmıştır.

4. PN radyografiler üzerinde yapılan ölçümlerde, flep grubunda lazer tedavisi uygulanmış ve uygulanmamış gruplarda istatistiksel olarak belirgin bir farklılık olduğu bulunmuştur ($p<0.05$). Lazer tedavisi uygulanmış grupta daha az kemik kaybı olduğu saptanmıştır.

5. Mini-flep grubunda PA ve PN radyografilerde lazer tedavisi uygulanan ve uygulanmayan gruplar arasında anlamlı bir farklılık göstermemiştir ($p>0.05$). Ancak, PA ve PN radyografilerde lazer tedavisi uyglanmayan grupta kemik kaybı daha fazladır ($p>0.05$).

6. Lazer tedavisi görmüş gruplarda, PA ve PN radyografiler flep ve mini-flep dizaynı arasında belirgin bir farklılık olmadığını göstermiştir ($p>0.05$). Ancak, istatistiksel olarak anlamlı olmasada mini-flep grubundaki kemik kaybı flep grubuna göre daha azdır.

7. Lazer tedavisi uygulanmamış gruplarda, PA ve PN radyografiler flep ve mini-flep dizaynları arasında belirgin bir farklılık göstermemiştir ($p>0.05$). Ancak, istatistiksel olarak anlamlı olmasada mini-flep grubundaki kemik kaybı flep grubuna göre daha azdır.

8. Çalışma süresince toplam altı implant kaybı olmuş, bunlardan üçü lazer tedavisi yapılmış olan gruba dahil iken, diğer üçü lazer tedavisi yapılmamış gruba ait idi. Yanısıra, kaybedilen implantların beş tanesi konvensiyonel flep tekniği ile yerleştirilmiş, geri kalan bir tanesinde ise mini-flep tekniği kullanılmıştır.

Elde edilen sonuçlar göstermektedirki, uygulanan lazer seanslarının arttırılması ve seanslar arasındaki sureninde kısaltılması gerekmektedir. Özet olarak daha sık ve çok sayıda lazer uygulanması tavsiye edilmektedir.

Yine elde edilen sonuçlara göre, PN radyografiler tek başlarına kullanılabilirler. Ancak, PN radyografilerin yeterli netlikte olmadığı durumlarda PA radyografiler ile desteklenmelidirler.

Yapılan ölçümler göstermiştirki, LLLT kemik içi implant uygulamalarında iyileşmeyi hızlandırmak için umut verici bir tedavi yaklaşımıdır. Uygulamalar arası sürenin kısaltıması önerilmektedir.

Mini-flep ve konvensiyonel flep tekniği arasında anlamlı bir fark bulunamamasına karşın, flep grubunda daha fazla implant kaybı olduğu saptanmıştır. Doğru hasta seçimi yapılması kaydı ile, implant uygulamalarında mini-flep tekniğinin tercih edilmesi önerilmektedir.

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12.SUPPLEMENT

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