Original Research Article

Assessment of Hard Tissue Density Around Dental Implants

Dental İmplantlar Çevresi Kemik Yoğunluğunun Değerlendirilmesi

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ABSTRACT

Introduction: The aim of this study to analyse the post surgical bone resorption around dental implants using two different radiographic techniques

Material and Methods: In this study, there were total of 27 otherwise healthy patients attended and 54 dental implants were applied to these patients bilaterally. Group A consisted of 15 patients who underwent to conventional flap surgical technique, while 12 patients in group B underwent to mini-flap procedure. All the patients received GaAlAs diode laser to one side and the other side was kept as a control. Radiographs were taken directly after the implants were inserted, then 1st and 3rd month following the operation.

Results: There found to be there is no statistically significant difference in hard tissue density around dental implants between mini or conventional flep groups wether GaAlAs diode laser applied or not by using two different radiographic analysis.

Conclusions: This study revealed that both flap groups irradiated or non-irradiated have not displayed any significant differences in the mean of bone resorption according to the radiological assessment done by both periapical and panoramic radiographs. However, there was a slightly less bone resorption in the irradiated mini-flap group than the non-irradiated conventional flap group. Therefore, LLLT may be a promising treatment modality for accelerating bone healing around dental implants, when used in increased doses and treatment schedules.

Keywords: GaAlAs laser; flap; implants; radiography

ÖZET

Giriş: Bu çalışmanın amacı, dental implantlar çevresindeki sert doku değişikliklerini iki farklı radyolojik görüntüleme tekniği kullanarak analiz etmektir.

Gereç ve Yöntem: Bu çalışmaya herhangi bir sistemik rahatsızlığı olmayan ve sigara içmeyen toplam 27 hasta dahil edildi ve bilateral olarak 54 dental implant uygulandı. Grup A, geleneksel flep cerrahisi tekniği uygulanan 15 hastadan oluşurken, grup B'deki 12 hastaya mini flep prosedürü uygulandı. Bütün hastalarda GaAlAs diyot lazer unilateral olarak uygulanıp diğer taraf kontrol tarafı olarak kabul edildi. Radyografiler implantlar yerleştirildikten hemen sonra ve takiben operasyondan 1 ay ve 3 ay sonra çekildi.

Bulgular: Periapikal ve panoramik radyografileri alınarak yapılan analizler sonucunda, konvansiyonel veya mini flep grubunda implantların etrafındaki kemik rezorpsiyonunda, GaAlAs diode lazer uygulansın veya uygulanmasın istatistiksel olarak önemli bir fark olmadığı saptanmıştır.

Sonuç: Bu çalışma, her iki farklı periapikal ve panoramik radyografiler ile yapılan radyolojik değerlendirmeye göre, GaAlAs diyot lazer verilen veya verilmeyen her iki farklı flep grubunda kemik rezorpsiyonunda anlamlı bir farklılık saptanmadığını ortaya koymuştur. Bununla birlikte, lazer uygulanan mini flep grubunda anlamlı olmamakla birlikte daha az kemik rezorpsiyonu gözlenmiştir. Bu nedenle, LLLT daha yüksek doz ve sık sayıda seanslar şeklinde uygulandığında, implant çevresi kemik yapıda iyileşmeyi hızlandırmada umut verici bir tedavi yöntemi olabilir.

Anahtar kelimeler: GaAlAs lazer; flep; implant; radyografi

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INTRODUCTION

The aim of dentistry is always to provide normal contour, function, comfort, esthetic, speech, and health, regardless of the bone atrophy, oral diseases, or injury of the oral cavity. However, more teeth a patient is missing, the goal becomes more challenging by the current dental treatment methods. Dental implant surgery starts with raising flap procedures for the dental 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 which is 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. In the last decade there has been an interest to provide function, esthetics, and comfort with a minimally invasive surgical approach. Flapless surgery involves accessing the bone by punching out a small amount of soft tissue, just the amount required for implant placement by drilling directly through the soft tissue. Procedure has many advantages for the patient as well as for the surgeon such as shorter surgical time, minimal bleeding and swelling, less postoperative discomfort, possibility of immediate loading, faster procedure of implant placement and less time needed for complete implant-prosthetic restoration. Two-stage technique, due to raising full-thickness periosteal flap may result by the 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 may also result in less postoperative discomfort and scar formation as well. Leaving the periosteum intact on the buccal and lingual aspects of the ridge maintains a better bloody supply to the site, reducing also the likelihood of resorption.[1,2] Despite the many benefits, 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 considerable undercut.[3]

Moreover, 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.[4] In hard tissues, low level laser irradiation (LLLT) was reported to speed up vascularization and to increase the number of trabeculae in fractured bone sites.[5] 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, in this way, it promotes an increase in cellular activity, increasing the concentration of adenosine tri phosphate (ATP), alkaline phosphatase (ALP), and liberating calcium. It is reported that LLLT may improve bone matrix production due to improved vascularization and anti-inflammatory effects.[4] 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.[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] 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) dental radiographs (PA) and panoramic radiographs (PN) have been recommended postoperatively.[8]

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

MATERIAL AND METHODS

Patients who had no history of any systemic disease or use of any medications referred to Gazi University Dental School Department of Oral and Maxillofacial Surgery for dental implant treatment between July 2008 and May 2009 were participated in this study. There were total of 27 patients (20 females, 7 males) attended. Total of 54 dental implants were applied to these patients. Their mean age was 36.5 (±13.62; min:17- max:68). All the patients of this study were otherwise healthy and non-smokers. The study protocol was reviewed and approved by the Local Ethics Committee of Gazi University, Dental School. Informed written consent was obtained from all the patients. Dental history, oral and radiographic examination, and a patient's dental and medical history were recorded. In this study, all the implants underwent 3-4 months healing period before the second stage of surgery to uncover the implants. After uncovering, a minimum of 7 days for the soft tissue healing period was allowed before the prosthetic procedures were begun.

Patients were divided into two groups according to the flap designs: Group A: Included 15 patients who had conventional flap (CF) design and Group B: Included 12 patients who had mini flap (MF) design. Each group was then divided into two sub-groups according to laser application as with laser and without laser group. CF design consisted of a horizontal incision on the crestal bone and it released medially with a vertical incision. The MF design had only a horizontal incision applied on the top of the crestal bone. After the reflection of the CF and the MF, the osteotomy was performed using special drills. After the osteotomy, diode laser was applied to the cavity in the 1st sub-group A and sub-group B. In the 2nd sub-group there was no diode laser application following the osteotomy. Each patient was radiographed immediately after the surgery and then postoperative 1st and 3rd months by PN and PA parallel technique radiographs.

Immediately after drilling, the socket was irradiated in the laser group. GaAlAs diode BTL 2000 portable laser (USA), with a wavelength 830 nm and a fluency of 3.0 J/cm², was employed for 39 sec in every session as suggested by the manufacturer protocol. Irradiation was applied to the socket before the implantation and following the stitches, and also on the 5th and 7th day postoperatively. All the irradiations were performed by the same operator. Nevertheless, implant at the opposite side not received laser irradiation, as being the control side.

PA radiographs with a parallel technique were taken with single-packed Kodak dental films on a radiograph machine (Trophy CCX, Vincennes, France) operating at 70kVp and 8mA, having 2.5eq aluminum 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 order to stabilize the angle of the PA radiographs, anterior and posterior Kerr Super-Bite Switzerland film holders were used. Each patient had individual partial impression which was obtained during the first pre-operative PA radiographs taken. The digital PN images were taken at 70-74kVp, 4-10 mA and 12s 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.

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). All unfiltered and filtered digital panoramic images were evaluated under subdued lighting conditions and the viewing distance was kept at approximately 70 cm.

The radiographs were converted to 14.9 MegaPixel digital images with a calibrated SONY α 350 Digital SLR Camera with CCD sensor. 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 medially 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 $p<0.05$.

Table 1. Assessment of bone loss on PA radiographs for both flap designs in the irradiated group.

Laser	Day	CF (n=30)	MF (n=24)	p	p^{CF}	p^{MF}
PA	**1st**	11.195±0.459 (10.248-12.141)	11.714±0.516 (10.650-12.779)	0.470	-	-
PA	**2nd**	10.413±0.510 (9.361-11.465)	10.876±0.573 (9.693-12.059)	0.563	0.015*	0.021*
PA	**3rd**	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*§

PA: Periapical radiograph
p Difference between the Conventional Flap and Mini Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^{CF}Conventional Flap (CF) group, p^{MF} Mini Flap (MF) group)
*p < 0.05

Table 2. Assessment of bone loss on PN radiographs for both flap designs in the irradiated group.

Laser	Day	CF (n=30)	MF (n=24)	p	p^{CF}	p^{MF}
PN	**1st**	11.453±0.448 (10.529-12.378)	11.721±0.504 (10.681-12.761)	0.703	-	-
PN	**2nd**	10.695±0.450 (9.765-11.625)	10.970±0.507 (9.924-12.016)	0.696	0.000*	0.001*
PN	**3rd**	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*§

PN: Panoramic radiograph
p Difference between the Conventional Flap and Mini Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^{CF}Conventional Flap (CF) group, p^{MF} Mini Flap (MF) group)
*p < 0.05

RESULTS

In this study, total of 54 titanium dental implants were placed in 27 patients: 24 implants in MF group and 30 implants in CF group. All the implants were inserted at the posterior molar area of both jaw (Mandible:26 implants; Maxillae:28 implants)

There was no significant difference between the CF and the MF group in day 1,2 and 3 for bone loss when the analysis was done on PA radiographs (p>0.05). However, there found to be a significant difference within the CF group between the day 1-2 and day 1-3 (p<0.05). In addition, in the MF group there also found to be a significant difference within the group between day 1, 2 and 3 (p<0.05). Resorption in day 3 in the MF was slightly more than the CF group (Table 1). In addition, there was no significant difference between the CF and the MF group in day 1,2 and 3 when the analysis was done on PN radiographs (p>0.05). However, there found to be a significant difference when CF and the MF groups where assessed within the group (p<0.05) (Table 2).

There was no significant difference between the CF and MF group in day 1,2 and 3 when the analysis was done on PA radiographs (p>0.05). However, there was a significant difference when CF and the MF groups where assessed within the group (p<0.05) (Table 3).

There was no significant difference between the CF and the MF group in day 1, 2 and 3 when the analysis was done on PN radiographs (p>0.05). However, there found to be a significant difference when CF and MF groups where assessed within the group (p<0.05) (Table 4).

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 MF approach has been reported to be 98.7%.[9] Implants that were placed with conventional flap elevation, the connective tissue between the barrier epithelium and the marginal bone were poorly vascularized. 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.[1,2] It has also been suggested that elimination of the mucoperiosteal flap may prevent potential postoperative bone resorption associated with flap elevation.[1] 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).[10] In most cases flap elevation 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 advantage for soft tissue healing and patient comfort.[11,12] Our findings support the results of Blanco *et al.* that there was a significant difference in term of bone resorption neither CF nor MF removal was used when evaluated by both PA (Table 1-3) and PN radiographs (Table 2-4).

You and co-workers reported that there was a small amount of bone loss during the healing process in the flap removal 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 removal group and 0.0 mm in the flapless group, and that this difference was statically significant ($p<0.05$).[13] The present study revealed that there was no significant difference in the average bone

Table 3. Assessment of bone loss on PA radiographs for both flap designs in the non-irradiated group.

No-Laser	Day	CF (n=30)	MF (n=24)	p	p^{CF}	p^{MF}
PA	**1st**	10.183±0.496 (9.160-11.206)	11.313±0.557 (10.162-12.463)	0.153	-	-
PA	**2nd**	9.376±0.516 (8.310-10.442)	10.671±0.581 (9.472-11.870)	0.118	0.000*	0.004*
PA	**3rd**	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*§

PA: Periapical radiograph
p Difference between the Conventional Flap and Mini Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^{CF} Conventional Flap (CF) group, p^{MF} Mini Flap (MF)group)
*p<0.05

Table 4. Assessment of bone loss on PN radiographs for both flap designs in the non-irradiated group.

No-Laser	Day	CF (n=30)	MF (n=24)	p	p^{CF}	p^{MF}
PN	**1st**	10.301±0.479 (9.313-11.289)	11.271±0.538 (10,159-12.382)	0.202	-	-
PN	**2nd**	9.521±0.444 (8.603-10.438)	10.574±0.500 (9.542-11.606)	0.138	0.000*	0.001*
PN	**3rd**	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*§

PN: Panoramic radiograph
p Difference between the Conventional Flap and Mini Flap group when compared
§ Difference between Day 1 and Day 3 within the group
(p^{CF} Conventional Flap (CF) group, p^{MF} Mini Flap (MF)group)
*p<0.05

loss in the irradiated CF group, it was only 0.07mm more than the MF group (Table 1-2) while the difference in the non-irradiated group was 1.21 mm (p>0.05) (Table 3-4).

When placing dental implants, a flap is elevated to better visualize the bone site that will receive the implants. Choice of mini-flap approach may require a certain degree of better clinical experience, and more importantly anatomic requirements (eg: sufficient bone quantity) must be fulfilled.[1-3] Our study confirmed that good clinical controls and sufficient radiographs was enough to apply the MF design, which no fenestrations were reported, and that the flap technique could be eliminated.

The usefulness of PN for vertical and pre-implantation bone measurements has been well documented by several authors.[8,14,15] PA radiographs have a higher resolution but are more time consuming to obtain.[16] However, the technologic superiority of PA films 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. Moreover, PN radiographs may be superior to PA films, however, they may get distorted geometrically, and magnify the structure imaged. These distortions have been reported to interfere with the evaluation of peri-implant loss.[15,16]

Furthermore, 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.[5] LLLT has enhanced the treatment of a variety of morbid states including alleviating pain, healing wounds, and resolving nerve injuries. Although recent research has reported that LLLT could stimulate osteogenesis in the surrounding tissue and osteointegration[5,6], results of the present study have not supported their results. Both laser and non-laser group displayed the same level of resorption.

CONCLUSION

In conclusion, this study revealed that both flap groups irradiated or non-irradiated have not displayed any significant differences in the mean of bone resorption according to the radiological assessment done by both PA and PN radiographs. Therefore, PN radiographs can be used alone, supplemented when necessary by PA radiographs in cases where the PN radiograph is not off sufficient quality. It is also determined that bone resorption around dental implants being slightly less in the irradiated MF group than the non-irradiated CF group. Therefore, LLLT may be a promising treatment modality for accelerating bone healing around dental implants, when used in increased doses and treatment schedules.

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