MAKU J. Health Sci. Inst. 2021, 9(2): 10-21.
doi: 10.24998/maeusabed.950439

Mehmet Akif Ersoy University
Journal of Health Sciences Institute
http://dergipark.gov.tr/maeusabed

Research Article / Araştırma Makalesi

Impact of Low-speed Drilling without Irrigation on Dental Implant Success

Düşük Devirli İrrigasyonsuz Frezlemenin Dental İmplant Başarısına Etkisinin Değerlendirilmesi

Mustafa KARACA[1]*, Abubekir ELTAS[2]

[1]Mehmet Akif Ersoy University, Faculty of Dentistry, Department of Periodontology, Burdur, Turkey
[2]Sağlık Bilimleri University, Faculty of Dentistry, Department of Periodontology, İstanbul, Turkey

Abstract: This study aimed to evaluate the effects of low-speed drilling without irrigation in implant site preparation on marginal bone loss around dental implants and implant failure. The study included a total of 23 patients with partial or complete edentation. The drilling of 44 implant sites in the study group was performed at low speed (50rpm) without irrigation, while 30 implant sites in the control group were drilled at high speed (600rpm) with saline irrigation. The same implant brand was used in both groups. In order to determine marginal bone levels, periapical radiographs were taken immediately after implantation and at postoperative 3 months. Also, certain values including implant failure rates, insertion torque values, bone quality in the implant site, drilling time, and total operation time were recorded in the study. There was no statistically significant difference ($p>0,05$) between low-speed drilling without irrigation (LDWI) and conventional drilling (CD) in terms of mesial, distal, and mean marginal bone loss. Implant failure rates were also similar between the groups ($p>0,05$). Besides, no difference was observed between groups in terms of insertion torque values, drilling time, and total operation time ($p> 0,05$). The findings of this study suggest that the impact of LDWI on marginal bone loss in postoperative recovery period, implant failure, and initial torque values is similar to that of CD protocol. However, further research with longer follow-up periods is needed to confirm the reliability of this novel technique.

Keywords: Autogenous bone graft, Dental implant, Low-speed drilling without irrigation.

Öz: Bu çalışmanın amacı; implant yuvasının preparasyonunda düşük devirli irrigasyonsuz frezlemenin implant etrafındaki marjinal kemik kaybına ve implantların kaybedilme oranına etkilerinin değerlendirilmesidir. Çalışmaya parsiyel ve total dişsizliğe sahip toplam 23 hasta dahil edildi. Çalışma grubundaki 44 implantın frezlemesi 50rpm düşük devirli irrigasyonsuz şekilde yapılırken, kontrol grubundaki 30 implantın frezlemesi 600rpm devirli ve irrigasyonlu bir şekilde yapıldı. Her iki grupta da aynı implant markası kullanıldı. Marjinal kemik seviyelerini belirlemek için tüm implantlardan, yerleştirildikten hemen sonra ve postoperatif 3. ayda periapikal radyografiler alındı. Ayrıca, çalışmada implantların kaybedilme oranı, yerleştirme tork değerleri, implant yerleştirilen bölgedeki kemik kalitesi, frezleme ve toplam ameliyat süreleri kaydedildi. Bu çalışmada; düşük devirli irrigasyonsuz frezleme (DDİF) ile standart frezleme (SF) protokolü arasında mesial, distal ve ortalama marjinal kemik kaybı düzeyleri açısından istatistiksel olarak anlamlı bir farklılık görülmedi ($p>0,05$). İmplantların kaybedilme oranları da gruplar arasında benzerdi ($p>0,05$). Ayrıca, implant yerleştirme tork değerleri, frezleme ve toplam ameliyat sürelerinde de gruplar arasında farklılık gözlenmedi ($p>0,05$). Bu çalışmanın bulguları, DDİF'nin cerrahi sonrası iyileşme dönemindeki marjinal kemik kaybı, implant kaybı ve başlangıç tork değerlerine etkilerinin SF ile benzer olduğunu işaret etmektedir. Ancak, tekniğin güvenilirliği açısından daha ileri ve uzun hasta takipli çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Dental implant, Düşük devirli irrigasyonsuz frezleme, Otojen kemik grefti.

*Corresponding author : Mustafa KARACA e-mail : karaca0790@gmail.com
Geliş tarihi / Received : 10.06.2021 Kabul tarihi / Accepted: 12.08.2021

Introduction

Today, dental implants are widely used in the treatment of partial or complete edentulism. The success of dental implants ultimately rests on the extent of osseointegration, that is, the direct adhesion between the bone and the implant surface. To ensure osseointegration, several factors, such as the quality of the bone into which implants are inserted, preferred surgical technique, as well as the tissue compatibility, surface properties, load transfer, and design of the implant material, are known to play a role(Eriksson and Adell, 1986).

During implant surgery, excessive stress and heat should not be created on the bone, avoiding any traumatic procedures. Excessive stress during the procedure causes bone resorption, thus hindering successful osseointegration. The most important issue to consider while drilling an implant site in the bone is the friction heat generated between the burr and the bone (Eriksson and Adell 1986). Authors reported that heating bony tissue to 47°C for one minute leads to death of osteogenic cells with no successful recovery (Tehemar 1999). Exposing bones to high temperatures has been found to cause dislocation in the cage structure of hydroxyapatite minerals and microscopic denaturation. Heat generation during the drilling in the implant site is influenced by several factors which include the torque applied by the surgeon during drilling, drilling speed, drilling time, irrigation and implant systems, design and sharpness of the burr, material of the burr, bone quality in the implant site, drilling depth and patient-related factors (Möhlhenrich et al. 2015).

The speed of drilling is one of the key factors to determine heat generation in the bone during implant surgery. Excessive drilling speeds have been reported to cause heat generation, which may lead to thermal osteonecrosis by limiting the effectiveness of irrigation. On the other hand, some studies found that low-speed drilling might require longer drilling time and higher drilling torque as compared to high-speed drilling, thus resulting in overheating in the bone tissue (Gil et al. 2017).

Dental implantology and surgical techniques are now updated on a continuous basis. In most implant systems, conventional drilling speeds ranging from 600 rpm to 1500 rpm and abundant irrigation are generally recommended to prevent heat generation in the bone tissue (Sharawy et al. 2002; Reingewirtz et al. 1997). Recently, a novel technique involving low-speed drilling without irrigation (LDWI) has been proposed as an alternative to conventional procedures employed to prepare implant site during implant surgery. This technique allows autogenous bone harvesting, which could yield additional bone graft, one of the most important factors in implant surgery today (Anitua et al. 2007). It has been reported that the bone graft harvested during low-speed drilling is easier to manipulate as compared to grafts obtained through other methods such as bone clamp and bone collector. As no irrigation is used in this novel technique, contamination of the collected autogenous graft with saliva can also be avoided. In addition, low-speed drilling ensures a more controlled osteotomy (Gaspar et al. 2013).

In this study, we aimed to determine the impacts of low-speed drilling without irrigation on marginal bone loss around implant site, number of failed implants, insertion torque values and operation time, as it is becoming a more common clinical application despite limited amount of scientific evidence.

Material and Methods

Study Design

This randomized, controlled, clinical trial included 23 patients without any systemic complaints who presented to the Department of Periodontology at the Dentistry Faculty of İnönü University. A total of 74 dental implants (36 maxillary and 38 mandibular implants) were applied in 23 patients with partial or complete edentation. Prior to the commencement of any research protocol, a written approval (no. 2017/71) was obtained from Malatya Ethics Committee of Clinical Investigations. Besides, a written informed consent was obtained from each participant before the application of implant treatment.

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

Two groups were formed: a study group and a control group. In the study group, a new protocol of low-speed drilling without irrigation (LDWI) at 50 rpm, with initial drilling performed at a speed of 600 rpm, was used in the preparation of implant sites (n = 44).

In the control group, conventional drilling (CD) protocol was employed, where implant sites were drilled at a speed of 600 rpm with irrigation using physiological saline (n = 30).

In the study, some patients received implants prepared through both CD and LDWI protocols in their different quadrants, in an attempt to rule out possible differences in implant success due to the personal physiological factors.

Patients

Inclusion criteria

Patients volunteering to participate in the study and meeting the following the criteria were included in the study.

● Age over 18 years

● At least one missing tooth

● Alveolar crest thickness greater than 5 mm

● No systemic health complaints

Exclusion criteria

Patients meeting the following the criteria were excluded from the study.

● Non-steroidal anti-inflammatory drug allergy

● History of periodontitis during the implant treatment

● History of chemotherapy and/or radiotherapy

● Tobacco consumption

● Existence of pregnancy or possible pregnancy

● Diseases affecting oral mucosal health

● Systemic disease and drug use that may cause surgical complications

● History of recent tooth extraction in the treatment area (within 4 months of the treatment)

● Failure to attend follow-up appointments scheduled after the operation

Surgical Technique

All surgical procedures were carried out in accordance with sterilization and disinfection guidelines in an operating theater in the Department of Periodontology at the Dentistry Faculty of Inonu University. Prior to surgery, implant areas were anesthetized with local anesthetics (Maxicaine Fort, Articaine hydrochloride 80 mg + epinephrine 0.020 mg/ampoule). After the state of anesthesia was achieved, sulcular and crestal incisions were made in the implant area by means of a scalpel size no. 15 (Broche Medical scalpel blade, carbon steel). Next, the mucoperiosteal flap was raised through the use of a periosteal elevator (Schwert Periosteal Elevator, Hu-Friedy) to proceed with the preparation of the implant site.

Figure 1. Surgical instruments used for dental implants.

In preparation of the implant site, the initial drilling was performed at a speed of 600 rpm with irrigation. Then, two groups were formed as study group and control group. In the study group, drilling was continued at 50 rpm without irrigation, while in the control group the implant site was

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

drilled at 600 rpm with irrigation using physiological saline.

Once the implant site had been prepared, the selected implant was inserted in the site by means of a carrier piece. All implants in the study were positioned at bone level or 1mm below the bone level. As we preferred a two-stage dental implant placement method, first the closure screws were inserted and then the wound edges were primarily closed with 4.0 propylene sutures (Doğsan, Istanbul, Turkey) to cover the implant head. All these surgical procedures were performed by a single surgeon for the standardization of treatments.

Figure 2. Autogenous graft collected with LDWI technique.

Measurement of Insertion Torque

Initial stabilization of the implants was evaluated by measuring the insertion torque values. In accordance with the manufacturer's recommendations, the torque values were measured by a manually calibrated torque ratchet with a digital display. The torque values recorded here were grouped as follows:

T1: 0-19 Ncm

T2: 20-40 Ncm

T3: 41-60 Ncm

T4:> 60 Ncm

Assessment of Bone Quality

The jawbone types of the patients were graded subjectively on a scale of 1 to 4 by the surgeon placing the implants based on the resistance to the drilling process during preparation of the implant sites, in accordance with the classification criteria specified by Bra-nemark et al. 1985 (Bra-nemark et al. 1985).

According to this classification,

• Type I: Almost the entire bone is composed of homogenous compact bone with small amount of trabeculae in the center.

• Type II: The bone is composed of a thick layer of compact bone surrounding a core of dense trabeculae.

• Type III: The bone is composed of a core of low-density trabeculae surrounded by a thin layer of cortical bone.

• Type IV: The bone is composed of fine trabecular bone surrounded by a thin layer of compact bone.

Measurement of Operation Time

The duration of the operation and the total time of drilling (excluding the initial drilling) were recorded by an assistant with a chronometer. Then the operation times were classified as follows:

A1: Less than 10 minutes (min)

A2: 10 minutes and more

The drilling times were classified as follows:

F1: 0-25 seconds

F2: 25.1-40 seconds

F3: 40.1-50 seconds

F4: 50.1 seconds

Postoperative Care

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

After surgery, each patient was advised to apply an extraoral ice compress to the affected area for 24 hours. A nonsteroidal anti-inflammatory analgesic drug (ibuprofen 600 mg 2x1) was prescribed for 4 days, as well as antibiotics (500 mg amoxicillin 3x1) and chlorhexidine mouthwash (3x1) for one week.

In addition, important points in the postoperative care were explained to each patient either verbally or in writing. The sutures were remove done week after the surgery.

Measurement of Marginal Bone Loss

Standardized periapical radiographs taken immediately after placement of the implants and at postoperative 3 months were transferred to digital media. The X-ray images were assessed in accordance with specifications described by Dinato et al. Accordingly, all X-ray images were sent using the same equipment with a focus distance of 70 kVp, 8 mA, 0.2 sec and about 30 cm. Next, the size of the dental implants was measured using the Planmeca Romexis 3.5.1.R program on periapical radiographs. The size of the implants measured on the radiograph was calculated to find their direct proportion to the actual size of the implant and then the amount of growth on periapical radiographs was calculated. The mean marginal bone levels measured from mesial and distal points with reference to the implant neck were determined according to the amount of growth. The difference in marginal bone levels obtained from both digital periapical radiographs was measured and recorded 3 times by two researchers. The mean bone level percentage for an implant was calculated by taking the mean value of the mesial and distal measurements ($(M + D)/2$) (Figures 3.3 and 3.4) (Kılıç et al. 2013; Dinato et al. 2016; Sesma et al. 2016)

Statistical Analysis

The research data were analyzed on the software package called IBM SPSS Statistics 22 for statistical analysis (SPSS IBM, Turkey). The Shapiro-Wilk test was used to determine whether the parameters departed from normality, and we found that the parameters did not show normal distribution. Mann-Whitney U test was used for the comparison of parameters between groups. Chi-square test, Fisher's Exact Chi-square test, Continuity (Yates) Correction and Fisher Freeman Halton test were used for comparison of qualitative data. A p-value less than 0.05 ($p<0.05$) was considered statistically significant.

Results

This study included a total of 74 dental implants (44 in the study group and 30 in the control group). The demographic data of the patients are presented in Table 1. Three implants in the study group and two implants in the control group failed in the osseointegration phase, thus the success rate of all implants was 93.3%. There was no implant or patient excluded from the study in either group.

Table 1. Demographic characteristics of the patients by groups

	LDWI	CD
Number of patients	15	14
Number of implants (n)	44	30
Age (years)	49.3	43.8
Gender		
Female	7	7
Male	8	7

The mean marginal bone loss was 0.49±0.42mm in the radiographic evaluation (at 3 months) of the implants placed in the LDWI group and 0.44±0.35mm in the control group, and there was no statistical difference between groups. In addition, there was no statistically significant difference between groups in terms of mesial and distal marginal bone loss ($p>0.05$) (Table 2).

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

Table 2. Mean marginal bone loss around implants.

	LDWI (n=44) Mean±SD	CD (n=30) Mean±SD	p
Mesial marginal bone loss (mm)	0.45±0.40	0.43±0.35	0.700
Distal marginal bone loss(mm)	0.53±0.47	0.45±0.39	0.431
Mean marginal bone loss(mm)	0.49±0.42	0.44±0.35	0.537

Mann-Whitney U Test.

Table 3. Implant failure rates.

	LDWI (n=44) n (%)	CD (n=30) n (%)	*Total (n=74) n (%)*	P
Implant loss				
Yes	3 (%6.8)	2 (%6.6)	*5 (%6.7)*	[2]1.000
No	41 (%93.1)	28 (%93.3)	*69 (%93.3)*	

[1]Fisher Freeman Halton Test; [2]Continuity (Yates) Correction; *p<0.05; T1:0-19, T2:20-40, T3:41-60, T4:>60.

Table 4. Insertiontorque values and bone quality in implant sites

LDWICD	Total	p			
		(n=44)	(n=30)	(n=74)	
Bone Quality					
	Type 1	1 (%2.3)	2 (%6.7)	*3 (%4.1)*	[1]0.720
	Type 2	16 (%36.4)	13 (%43.3)	*29 (%39.2)*	
	Type 3	21 (%47.7)	12 (%40)	*33 (%44.6)*	
	Type 4	6 (%13.6)	3 (%10)	*9 (%12.2)*	
Insertion Torque					
	T1	9 (%20.5)	5 (%16.7)	*14 (%18.9)*	[1]0.532
	T2	18 (%40.9)	12 (%40)	*30 (%40.5)*	
	T3	5 (%11.4)	1 (%3.3)	*6 (%8.1)*	
	T4	12 (%27.3)	12 (%40)	*24 (%32.4)*	

[1] Chi-square Test; [2] Fisher's Exact Test; [3] Fisher Freeman Halton Test; [4]Continuity (Yates) correction; *p<0.05.

About 6.8% of the implants in the LDWI group and 6.6% of the implants in the control group were lost and there was no statistically significant difference between the groups (p>0.05) (Table 3).

Both groups showed similar bone quality in the regions where implants were placed (p>0.05) (Table 4).

Table 5. Drilling and operation times

	LDWI	CD	*Total (n=74)*	P

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

	(n=44)	(n=30)		
Drilling time				
F1 (%)	22 (%50)	11 (%36.7)	*33 (%44.6)*	[1]0.167
F2 (%)	17 (%38.6)	9 (%30)	*26 (%35.1)*	
F3 (%)	2 (%4.5)	4 (%13.3)	*6 (%8.1)*	
F4 (%)	3 (%6.8)	6 (%20)	*9 (%12.2)*	
Operation time				
A1 (%)	22 (%50)	11 (%36.7)	*33 (%44.6)*	[2]0.371
A2 (%)	22 (%50)	19 (%63.3)	*41 (%55.4)*	

[1]Fisher Freeman Halton Test; [2]Continuity (Yates) Correction; *$p<0.05$
F1:0-25sec, F2:25.1-40sec, F3: 40.1-50sec, F4:50.1sec; A1:Under 10 min, A2:Over 10 min.

There was no statistically significant difference in the initial torque values between the LDWI and CD groups ($p>0.05$) (Table 4).

There was no statistically significant difference between the groups in terms of drillingand operation times ($p> 0.05$) (Table 5).

In both LDWI and CD groups, there was no statistically significant correlation between implant failure and torque values, drilling and operation times ($p> 0.05$) (Table 6, 7).

Table 6. Evaluation of the relationship between implant failure and initial torque values, drilling and operation times in the LDWI group.

	Implant Failure		p
	No n (%)	Yes n (%)	
Initial torque values			
T1	9 (%100)	0 (%0)	[1]0.223
T2	18 (%100)	0 (%0)	
T3	4 (%80)	1 (%20)	
T4	10 (%83.3)	2 (%16.7)	
Drilling time			
F1	21 (%95.5)	1 (%4.5)	[1]0.548
F2	16 (%94.1)	1 (%5.9)	
F3	2 (%100)	0 (%0)	
F4	2 (%66.7)	1 (%33.3)	
Operation time			
A1	21 (%95.5)	1 (%4.5)	[2]0.345
A2	20 (%90.9)	2 (%9.1)	

[1]Fisher Freeman Halton Test; [2]Fisher's Exact Test; T1: 0-19 Ncm, T2: 20-40 Ncm, T3: 41-60 Ncm, T4: >60 Ncm; F1: 0-25 sec, F2: 25.1-40 sec, F3: 40.1-50 sec, F4: 50.1 secA1:Under 10 min, A2:Over 10 min.

Table 7. Evaluation of the relationship between implant failure and initial torque values, drilling and operation times in the CD group

	Implant Failure		p
	No n (%)	Yes n (%)	

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

Initial torque values			
T1	4 (%80)	1 (%20)	[1]0.366
T2	12 (%100)	0 (%0)	
T3	12 (%92.3)	1 (%7.7)	
Drilling time			
F1	11 (%100)	0 (%0)	[1]1.000
F2	8 (%88.9)	1 (%11.1)	
F3	4 (%100)	0 (%0)	
F4	5 (%83.3)	1 (%16.7)	
Operation time			
A1	10 (%90.9)	1 (%9.1)	[2]0.537
A2	18 (%94.7)	1 (%5.3)	

[1]Fisher Freeman Halton Test; [2]Fisher's Exact Test; T1: 0-19 Ncm, T2: 20-40 Ncm, T3: 41-60 Ncm, T4: >60 Ncm F1:0-25 sec, F2:25.1-40 sec, F3: 40.1-50 sec, F4: 50.1 secA1:Under 10 min, A2:Over 10 min.

Discussion

This study was carried out to determine the impact of LDWI and CD protocols on marginal bone loss around dental implants and implant failure. When the effect of LDWI on marginal bone loss and implant failure rates was assessed, early results were found to be similar to those of CD protocol. It was also observed that the insertion torque values, drilling and operation times did not differ between the groups.

Modern implantology has been showing a constant progress over the past century (Fiorellini et al., 1998; Lioubavina-Hack et al., 2006). Today, implant surgery often requires bone graft material depending on the amount of insufficient bone in the host tissue. It has been reported that the most ideal bone grafts used in implant surgery are of autogenous origin. Clinicians usually obtain autogenous bone grafts by using instruments specifically designed to harvest bone during drilling in the jawbone or through suction tip to collect bone particles produced by drilling. However, autogenous bone grafts harvested through these methods are generally inadequate and contaminated by oral bacteria existing in saliva (Kim et al. 2010). Anitua et al. (2007) introduced a protocol for the preparation of the implant site, where initial drilling is performed at 800 rpm with irrigation and the subsequent drilling is continued at 50 rpm without irrigation by progressively increasing the diameter of the burr. They reported that this protocol could easily yield more autogenous bone graft that is not contaminated by saliva as compared to other methods. It has also been reported that this technique does not impair bone tissue viability and that implants do not interfere with osseointegration process. Since the introduction of LDWI protocol in the literature, several studies have been carried out to examine the effects of this technique on the temperature change in the bone tissue. In their study conducted on pig rib bones, Kim et al. (2010) compared the effects of conventional drilling (1200 rpm) and low-speed drilling (50 rpm) on temperature changes in bone using infrared thermography. In this study, they found no significant difference between the groups in terms of temperature increase, reporting that drilling at 50 rpm without irrigation did not cause excessive heat in bone and that a few degrees of temperature difference might be related to the burr diameter. Giro et al. (2013), carried out on diaphysial radius of beagles, examined the effects of osteotomy at 900 rpm with irrigation and osteotomy at 50 rpm without irrigation on implant integration. They found that both techniques yielded similar results and did not affect implant integration in the early integration period, based on the measurements of bone-to-implant contact and bone area fraction occupancy

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

in follow-up period at 2 and 4 weeks. In their study on rabbit tibia, Gaspar et al. (2013) investigated the histological sections of the implant sites drilled at 50 rpm without irrigation and at 800 rpm with irrigation, and they reported that both surgical techniques protected the vitality of the bone cells. In their laboratory study on type 4 bovine bone disks, Delgado Ruiz et al. (2018)compared the heat changes caused by LDWI technique(50 rpm, 150 rpm, 300 rpm) and drilling at 1200 rpm with irrigation. They concluded that LDWI design caused a temperature increase at the coronal and apical levels, though it remained below the critical level of 47°C.(Oh et al. 2016), in a study on experimental D1 bone, reported that LDWI (50 rpm) and the high-speed drilling with irrigation (1500 rpm) did not cause overheating in the bone tissue. The research in the relevant literature indicates that low-speed drilling without irrigation causes no significant change in bone temperature, but all of the previous work seems to consist of laboratory or animal studies. For this reason, clinical studies on humans are needed to fully understand the effects of LDWI protocol on bone tissue. Our study therefore aimed to examine the clinical effects of the implant site preparation with LDWI on human jawbone, as clinical applications of this novel technique are becoming widespread day by day and respective scientific evidence is currently rather limited in the literature.

Even though various methods are employed in evaluating marginal bone around implants, the most common tool is still radiographs. Radiological evaluation of dental implants involves the use of several different imaging methods. Some researchers utilize periapical radiographs to evaluate the bone around implants in clinical trials, while others prefer panoramic radiographs (Leimola-Virtanen et al. 1995; Spiekermann et al. 1995; Romeo et al. 2002). Åkesson et al. (1992) compared panoramic and periapical radiographs in evaluating marginal bone and reported that the image quality of periapical radiographs was superior. Panoramic radiographs have certain disadvantages; for instance, they cannot provide a detailed image of the bone level around the implant and radiographic images of the implants placed in the anterior region often suffer from deformation and superposition. For this reason, periapical radiographs are preferred in periodic monitoring after an implant surgery (Åkesson et al. 1992; Åstrand et al. 2002; Buser et al. 1997). In our study, we therefore used periapical radiographs to calculate the amount of bone graft required and marginal bone loss during routine follow-up of patients.

Nowadays, radiographic evaluation through computer-assisted measurements allows a more precise assessment of the peri-implant regions. Moberg et al. (1999) used a computer-assisted measurement method to determine the bone level around the implants in a clinical trial. During the measurement, each radiograph was evaluated by comparing the radiographic and actual dimensions of the implants in order to rule out possible errors that might be caused by the magnification differences. Wyatt et al. (2001) reported that the computer-assisted measurement of bone level around the implant was more advantageous and indicated that different perspectives between individuals in the measurements made with magnifiers could vary significantly. Therefore, in our study, computer-assisted measurements were performed to increase the precision of the results obtained on periapical radiographs taken to assess the amount of bone resorption around the implants.

Today, widespread adoption of dental implants has brought about the need for more research to maximize the reliability of implant treatment and successful survival of implants (Sesma et al. 2016). To that end, some success criteria have been defined in order to evaluate the state of dental implants. These criteria mainly cover subjective complaints such as pain, foreign body sensation, infection, neuropathy, paresthesia, survival and mobility of implants, and radiographic marginal bone loss (Çetiner and Zor, 2007). According to Albrektsson et al. (1986), marginal bone loss of ≤

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

1 mm in the first year after an implant has become functional and ≤ 0.2 mm annually in the following years is considered successful. In Brånemark implant systems, the total loss in the marginal bone should be about 1.2 mm after one year of loading in active implants. It has also been reported that the mean annual bone loss should not exceed 0.1 mm in the follow-up period (Åstrand et al. 2002). Oh et al. (2002) mentioned that the initial marginal bone loss in the osseointegration process of the implant is affected by surgical trauma, excessive occlusal loading, peri-implantitis, peak module of the implant, and the way the surgical procedure is performed. Misch et al. (1999) stated that marginal bone loss during implant osseointegration was 0.21 mm for impacted implants and 0.36 mm for exposed implants. Pham et al. (1994) reported increased bone loss with prolongation of osseointegration in implants, with a mean bone loss of 0.48-0.96 mm in the 3-6 month period before loading. In the current literature, there exists no study to examine the effects of LDWI on marginal bone loss. In our study, the marginal bone loss measured in LDWI and CD groups were similar at the end of the 3-month osseointegration process.

While a failure occurring prior to implant osseointegration is considered an early failure, failures occurring after osseointegration under functional forces are categorized as late failure (Brunski 1992). Factors causing early failure of implants include bone necrosis, bacterial contamination, poor bone quality, micromovement of the implant, premature loading and inadequate primary stabilization (Lee et al. 2011). Dental implants usually feature a relatively high pre-loading success rate (Oh et al. 2002). Relevant studies have generally reported an implant failure rate of 2-3%. Chrcanovic et al. (2017) reported early failure in 642 of 10,096 implants (6.36%) in a retrospective study. In another retrospective research by Lin et al. (2018), 194 of 30,959 implants (0.6%) were reported to suffer early failure. Friberg et al. (1991) stated that 69 of 4,641 (1.5%) Brånemark implants included in the study failed during the osseointegration period. It is evident that implant failure rates may vary significantly from one study to another, which can be associated with the fact that implant failure may be caused by several factors, such as preferred surgical technique, implant surface characteristics, competence of the surgeon, and patient-related risk factors. There is no previous work in the literature attempting to determine the relationship between LDWI and implant failure. In our study, the implant failure rate was 6.8% in LDWI group and 6.6% in the control group, with no significant difference between groups. The rates of implant failure reported by the above-given corpus and meta-analyses involve great number of dental implants. However, the total number of implants in our study was only 74. For this reason, further research including larger number of implants with longer follow-up periods is warranted to confirm the reliability of the implant failure rates achieved by LDWI protocol.

Campos et al. (2012) reported that high insertion torque values could trigger bone necrosis and thus cause implant failure. Ottoni et al. (2005) reported that every 9.8-Ncm increase in torque values reduced the risk of implant failure by 20%, but there was no significant relationship between insertion torque and implant failure. In their systematic review, Berardini et al. (2016) compared the effects of high and low insertion torque values on implant failure, and they found that insertion torque had no significant impact on implant failure. In our study, we found no correlation between insertion torque values and implant failure rates.

The temperature increase in the bone is directly proportional to the drilling time, and one of the primary factors to extend the drilling time is obviously the drilling speed. In a study by Stelzle et al. (2012), which compared three different drilling systems (piezosurgery, spiral burr, trephine burr),implant site preparation with spiral burr took 5.9 seconds, with trephine burr 7.3 seconds and with piezoelectric surgery 19.5 seconds. They also

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

ISSN: 2148-2837/ MAKU J. Health Sci. Inst.

reported that the lowest temperature measured at maximum load was achieved by spiral burr (40.3 °C) followed by trephine burr (43.9 °C) and piezoelectric surgery (48.6 °C). Rashad et al. (2011) in their study on animal bones, compared two ultrasonic devices and a conventional device for implant site preparation, and they concluded that preparation with ultrasonic devices resulted in higher bone temperature and longer drilling time, also suggesting that ultrasonic devices can be safely used by increasing the amount of irrigation. Kim et al. (2010) demonstrated lower drilling speed increased drilling time but caused no higher bone temperature. Delgado Ruiz et al. (2018) also reported that the drilling process took longer at low speeds and the amount of heat generated in the bone increased while remaining below the critical threshold of 47°C. Reingewirtz et al.(1997), on the other hand, concluded that the drilling speed would increase the drilling time, which in turn could cause higher bone temperature. Thompson et al. (1958) also reported that the lower drilling speed should require more time and thus generate more heat, adding that increased heat would create necrotic bone tissue in the implant site and result in implant failure or lower implant success. In our study, we also recorded and compared the drilling and operation times required in LDWI and control groups. In addition, the relationship between implant failure and drilling and operation times was examined. Our results showed that both groups had similar drilling and operation times, with no significant difference in the rates of implant failure. Accordingly, low-speed drilling had no effect on the duration of operation and drilling. The similar operation and drilling times in the study and control groups could be explained by the fact that initial drilling was performed at standard speed with irrigation, and so the implant failure rates showed no significant difference between groups.

Conclusion

Based on the results of our study, we conclude that low-speed drilling without irrigation can be safely applied for implant site preparation in clinical settings. However, further studies are needed for this novel technique to become a routine clinical practice.

References

Åkesson, L., Håkansson, J., Rohlin, M., 1992. Comparison of panoramic and intraoral radiography and pocket probing for the measurement of the marginal bone level. Journal of Clinical Periodontology 19, 326-332.

Albrektsson, T., Zarb, G., Worthington, P., Eriksson, A.R., 1986. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. The International Journal of Oral & Maxillofacial Implants 1, 11-25.

Anitua, E., Carda, C., Andia, I., 2007. A novel drilling procedure and subsequent bone autograft preparation: a technical note. International Journal of Oral and Maxillofacial Implants 22, 138.

Åstrand, P., Feldmann, H., Engquist, B., 2002. Marginal bone reaction to oral implants: a prospective comparative study of Astra Tech and Brånemark System implants. Clinical Oral İmplants Research 13, 30-37.

Berardini, M., Trisi, P., Sinjari, B., Rutjes, A., Caputi, S., 2016. The effects of high ınsertion torque versus low ınsertion torque on marginal bone resorption and ımplant failure rates: a systematic review with meta-analyses. Implant Dentistry 25, 530-540.

Bra-nemark, Per-Ingvar; Zarb, G.A.; Albrektsson, T; Rosen, H.M., 1986. Tissue-ıntegrated prostheses. osseointegration In: clinical dentistry, plastic and reconstructive surgery 77(3) pp. 496-497.

Brunski, J.B., 1992. Biomechanical factors affecting the bone-dental implant interface. Clinical Materials 10, 153-201.

Buser, D., Mericske-Stern, R., Bernard, J., Behneke, A., 1997. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. Clinical Oral Implants Research 8(3), 161-72.

Campos, F.E., Gomes, J.B., Marin, C., Teixeira, H. S., 2012. Effect of drilling dimension on ımplant placement torque and early osseointegration stages: an experimental study in dogs. Journal of Oral and Maxillofacial Surgery 70, 43-50.

Chrcanovic, B.R., Kisch, J., Albrektsson, T., Wennerberg, A., 2017. Survival of dental implants placed in sites of previously failed implants. Clinical Oral Implants Research 28, 1348-1353.

Çetiner S, Zor F. 2007. Dental implantolojide başarıyı etkileyen faktörler. Gazi Üniversitesi Diş Hekimliği Fakültesi Dergisi 24, 51-56.

Delgado Ruiz, R.A., Ortega, E.V., Romanos, G.E., Gerhke, S., Newen, I., Calvo-Guirado, J.L., 2018. Slow drilling speeds for single-drill implant bed preparation. Experimental in vitro study. Clinical Oral Investigations 22(1), 349-359.

Dinato, T.R., Grossi, M.L., Teixeira, E.R., 2016. Marginal bone loss in ımplants placed in the maxillary sinus grafted with anorganic bovine bone: a prospective clinical and radiographic study Journal of Periodontology 87, 880-887.

Eriksson, R.A., Adell, R., 1986. Temperatures during drilling for the placement of implants using the osseointegration technique. Journal of Oral and Maxillofacial Surgery 44, 4-7.

Fiorellini, J.P., Martuscelli, G., Weber, H.P., 1998. Longitudinal studies of implant systems. Periodontology 2000 17, 125-131.

Friberg B., Jemt, T., Lekholm, U., 1991. Early failures in 4,641 consecutively placed Brånemark dental implants: a study from stage 1 surgery to the connection of completed prostheses. The International Journal of Oral & Maxillofacial Implants 6(2), 142-146.

Gaspar, J., Borrecho, G., Oliveira, P., 2013. Osteotomy at low-speed drilling without irrigation versus high-speed drilling with irrigation: an experimental study. Acta Medica Portuguesa 26, 231-236.

Gil, L.F., Sarendranath, A., Neiva, R., Marão, H.F., Tovar, N., Bonfante, E.A., Janal, M.N., Castellano, A., Coelho, P.G., 2017. Bone healing around dental ımplants: simplified vs conventional drilling protocols at speed of 400 rpm. International Journal of Oral & Maxillofacial Implants 32(2), 329-336.

Giro, G., Tovar, N., Marin, C., Jimbo, R., Suzuki, M., Janal, M.N., Coelho, P.G., 2013. The Effect of simplifying dental ımplant drilling sequence on osseointegration: an experimental study in dogs. International Journal of Biomaterials 2013: 230310.

Kılıç, K., Kandemir, B., Kılınç, H., Kesim, B., 2013. İmplant üstü kron restorasyonlarda marjinal kemik kaybının incelenmesi. Cumhuriyet Dental Journal 16: 188-196.

Kim, S.J., Yoo, J., Kim, Y.S., Shin, S.W., 2010. Temperature change in pig rib bone during implant site preparation by low-speed drilling. Journal of Applied Oral Science : revista FOB 18, 522-527.

Lee, J.Y., Park, H.J., Kim, J.E., Choi, Y.G., 2011. A 5-year retrospective clinical study of the Dentium implants. The Journal of Advanced Prosthodontics 3, 229-235.

Leimola-Virtanen, R., Peltola, J., Oksala, E., Helenius, H., Happonen, R.P. (1995). ITI titanium plasma-sprayed screw implants in the treatment of edentulous mandibles: a follow-up study of 39 patients. The International Journal of Oral & Maxillofacial Implants 10(3), 373–378.

Lin G., Ye, S., Liu, F., He, F., 2018. A retrospective study of 30,959 implants: Risk factors associated with early and late implant loss. Journal of Clinical Periodontology 45(6), 733-743.

Lioubavina-Hack, N., Lang, N., 2006. Significance of primary stability for osseointegration of dental implants. Clinical Oral Implants Research 17, 244-250.

Misch, C., Dietsh-Misch, F., Hoar, J., Beck, G., Hazen, R., 1999. A bone quality-based implant system: first year of prosthetic loading. The Journal of Oral Implantology 25(3), 185-197.

Moberg, L., Köndell, P., Kullman, L., 1999. Evaluation of single-tooth restorations on ITI dental implants. A prospective study of 29 patients. Clinical Oral Implants Research 10, 45-53.

Möhlhenrich, S.C., Modabber, A., Steiner, T., Mitchell, D.A., Hölzle, F., 2015. Heat generation and drill wear during dental implant site preparation: systematic review. British Journal of Oral and Maxillofacial Surgery 53, 679-689.

Oh, J.H., Fang, Y., Jeong, S.M., Choi, B.H., 2016. The effect of low-speed drilling without irrigation on heat generation: an experimental study. Journal of the Korean Association of Oral and Maxillofacial Surgeons 42(1), 9-12.

Oh, T.J., Yoon, J., Misch, C., Wang, H., 2002. The causes of early implant bone loss: myth or science?. Journal of Periodontology 73(3), 322-33.

Ottoni, J.M.P., Oliveira, Z.F.L., Mansini, R., 2005. Correlation between placement torque and survival of single-tooth implants. The International Journal of Oral & Maxillofacial Implants 20, 769-776.

Pham A., Fiorellini, J., Paquette, D., Williams, R., Weber, H., 1994. Longitudinal radiographic study of

To cite this article: KARACA M, ELTAS A. (2021). Impact of Low-speed Drilling without Irrigation on Dental Implant Success. MAKU J. Health Sci. Inst., 9(2), 10-21.

crestal bone levels adjacent to non-submerged dental implants. The Journal of Oral Implantology 20(1), 26-34.

Rashad, A., Kaiser, A., Prochnow, N., 2011. Heat production during different ultrasonic and conventional osteotomy preparations for dental implants. Clinical Oral Implants Research 22, 1361-1365.

Reingewirtz, Y., Szmukler-Moncler, S., Senger, B., 1997. Influence of different parameters on bone heating and drilling time in implantology. Clinical Oral Implants Research 8, 189-197.

Romeo, E., Chiapasco, M., Lazza, A., Casentini, P., 2002. Implant-retained mandibular overdentures with ITI implants. Clinical Oral Implants Research 13, 495-501.

Sesma, N., Garaicoa-Pazmino, C., Zanardi, P., 2016. Assessment of marginal bone loss around platform-matched and platform-switched ımplants - a prospective study. Brazilian Dental Journal 27, 712-716.

Sharawy, M., Misch, C., Weller, N., Tehemar, S., 2002. Heat generation during implant drilling: the significance of motor speed. Journal of Oral and Maxillofacial Surgery 60, 1160-1169.

Spiekermann, H., Jansen, V., Richter, E., 1995. A 10-year follow-up study of IMZ and TPS implants in the edentulous mandible using bar-retained overdentures. The International Journal of Oral & Maxillofacial Implants 10(2), 231-243.

Stelzle, F., Frenkel, C., Riemann, M., Knipfer, C., Stockmann, P., Nkenke, E., 2012. The effect of load on heat production, thermal effects and expenditure of time during implant site preparation - an experimental ex vivo comparison between piezosurgery and conventional drilling. Clinical Oral Implants Research 25(2), 140-148.

Tehemar, S.H., 1999. Factors affecting heat generation during implant site preparation: a review of biologic observations and future considerations. The International Journal of Oral & Maxillofacial Implants 14(1), 127–136.

Thompson, H.C., 1958. Effect of drilling into bone. Journal of Oral Surgery 16, 22-30.

Wyatt, C., Bryant, S., Avivi-Arber, L., 2001. A computer-assisted measurement technique to assess bone proximal to oral implants on intraoral radiographs. Clinical Oral Implants Research 12, 225-229.