

# Evaluation of Crestal Bone Resorption around Dental Implants in Flapped and Flapless Surgical Techniques Depending on Cone Beam CT Scan (Comparative Study)

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## ABSTRACT

**Background:** The long term survival of dental implants is evaluated by the amount of crestal bone loss around the implants. Some initial loss of bone around dental implants is generally expected. There is reason to believe that reflecting a mucoperiosteal flap promotes crestal bone loss in the initial phase after an implant has been inserted. The surgical placement of a dental implant fixture is constantly changing and in recent years, there has been some interest in developing techniques that minimize the invasive nature of the procedure, with flapless implant surgery being advocated. The purpose of this study was to compare the radiographic level of the peri-implant bone after implant placement between traditional flapped surgery and flapless approach depending on CBCT during 24 weeks healing period.

**Materials and Methods:** A total of 25 Iraqi patients with an age range of 20-60 years who received 46 implants were randomly divided into two groups: a control group which involved 27 implants inserted by conventional flapped surgical approach and a study group which involved 19 implants inserted by flapless surgical approach. The bone level was measured by CBCT for each implant at buccal and palatal/lingual sides at two times, immediately after implant placement (base line data), and after 24 weeks healing period.

**Results:** There was **no significant** difference between study (flapless) and control (flapped) groups in the mean of total crestal bone resorption for buccal and palatal side after 24 weeks from implant placement ( $P=0.393$  for buccal side and  $P=0.214$  for palatal side). There was **highly significant** difference between buccal and palatal side regarding crestal bone loss around implants ( $P=0.001$ )

**Conclusions:** Bone resorption around dental implants placed with conventional flap surgery compared to flapless surgery does not seem to be influenced during the healing period before implant loading. (Received: 16/2/2019; Accepted: 17/3/2019)

## INTRODUCTION

Osseointegrated dental implants are usually placed with a flap approach, which is based on soft tissue flap reflection and repositioning with suture after implant placement. This traditional approach has several drawbacks: decreased suprapariosteal blood supply due to flap elevation procedures, which can theoretically lead to bone loss; patient discomfort, which includes pain, bleeding, edema, and a longer surgical time<sup>(1,2)</sup>.

The objective of modern implant treatment involves not only the successful osseointegration of the dental implant but furthermore an esthetic and functional restoration. The implant is required to be surrounded by stable peri-implant tissue levels that are in harmony with the existing dentition. Stable bone levels at or close to the implant margin (shoulder) are among the factors used to consider implant treatment successful<sup>(3,4)</sup>. Successful prosthetic reconstruction by dental implant mainly depends on the preservation of peri-implant bone<sup>(5,6)</sup>. In recent years, flapless surgery is increasingly becoming a routine clinical procedure, and has been reported to have a predictable outcome with high success rate.

This is facilitated by modern radiographic technologies and dental implant treatment planning software to perform three-dimensional evaluation of bone volume at anticipated implant sites<sup>(7)</sup>. Flapless surgery has several theoretical advantages. From a patient point of view, it shortens the surgical time, decreases discomfort by reducing swelling and pain and accelerates post-surgical healing. Moreover, the blood vessels of hard and soft tissues around the implant site are preserved. Some studies state that this less traumatic surgery implies reduced bone resorption<sup>(8)</sup>.

Nevertheless, flapless surgery has some risks due to the limitations of exposure in the surgical site. A reported risk is buccal or lingual cortical plate perforation. Therefore, the technique requires advanced clinical experience, and surgical judgement for appropriate case selection (patients with sufficient alveolar three dimensional bone and adequate keratinized gingiva)<sup>(9)</sup>.

Several studies report on bone resorption and ridge alterations after implant placement in humans<sup>(10)</sup> and animals<sup>(11,12)</sup>. Many studies in animals assess that leaving the periosteum in place with flapless implant surgery clearly decreases the bony resorption rate<sup>(13,14)</sup>, and according to some authors, the flapless procedure is superior to flap implant procedures for maintaining original mucosal shape surrounding implants<sup>(15)</sup>.

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Therefore, it can be speculated that similar events may occur in humans after implant surgery.

Imaging may aid in evaluating implant therapy outcomes, such as peri implant bone defects and level and bone to implant interface<sup>(16, 17)</sup>.

Recently, cone beam computed tomography (CBCT) has been heavily marketed for implant-based oral rehabilitation procedures, mainly for treatment planning<sup>(18)</sup>. Nevertheless, some studies have used the method for assessment of the marginal peri-implant bone level and thickness, primarily of the buccal bone, and outcome of regenerative procedures<sup>(19, 20, 21)</sup>.

This study aimed to compare the radiographic level of the peri- implant bone after implant placement between traditional flapped surgery and flapless approach depending on CBCT during 24 weeks healing period. The working hypothesis is that using flapless technique decrease crestal bone resorption around dental implant.

## MATERIALS AND METHODS

This clinical randomized prospective study was conducted from December 2017 to November 2018, it included 25 Iraqi patients who received 46 implants with an age range of 20-60 years. The patients were randomly divided into two groups: a control group which involved 27 implants inserted by conventional flapped surgical approach and study group which involved 19 implants inserted by flapless surgical approach. Preoperative clinical and radiographic assessment were done for all patients. One implant system was utilized in the study (Nucleoss Co., Turkey).

### Inclusion Criteria

1. Patients had to be at least 18 years of age
2. Implants to be placed at least 6 months after teeth extraction (healed sites).
3. Only those patients who did not need any soft or hard tissue augmentation.
4. A minimum distance of 2 mm to adjacent anatomical structures (mandibular canal, maxillary sinus, mental foramen, and adjacent teeth).
5. The Presence of attached non-mobile soft tissue at least 1.5 mm in thickness above the crest of bone in the area receiving the implant, as measured by reamer and stopper.
6. The presence of adequate bone width at least 5 mm, 3 mm apical to crest measured by bone caliper after measurement of soft tissue above the crest, no need for bone augmentation procedures.
7. Patients with good oral hygiene.

### Exclusion Criteria

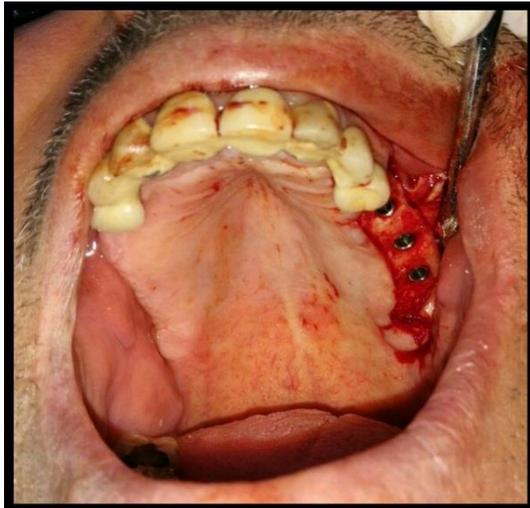
1. Insufficient keratinized tissue above the implant site (less than 2 mm above the ridge crest).
2. Insufficient bone width (less than 5 mm, 3 mm apical to crest).
3. Presence of any pathological condition adjacent to proposed implant site or at the implant zone.
4. Any medical conditions that could not withstand implant surgery or conditions that would interfere with normal healing mechanism including uncontrolled diabetes, osteoporosis, psychosis, current pregnancy at the time of surgical procedures.
5. Heavy smokers (more than 20 cigarette per day)
6. Patients with history of head and neck radiotherapy or chemotherapy over the past 5 years.
7. History or clinical evidence of para-functional habits such as bruxism and clenching.
8. Patients with active periodontitis.
9. Any dehiscence or fenestration of alveolar bone happened during the operation of implant placement.

### Surgical Procedures

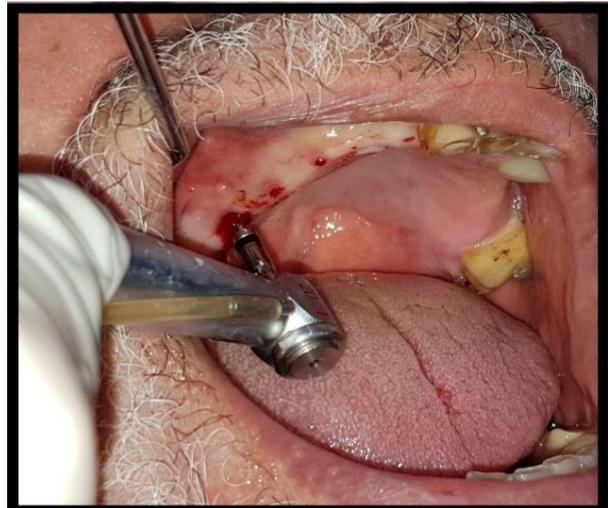
#### Flap Procedure (Control Group)

After anaesthetization with Lidocaine 2% by infiltration technique, a three sided flap (extensive flap design) or two sided flap was made initiated via paracrestal incision with palatal bias for better visibility, preserving a wider band of keratinized attached gingiva for more solid wound closure and avoiding wound dehiscence as seen in Fig (1).

Full thickness mucoperiosteal flap reflection to expose crestal and buccal alveolar bone using periosteal elevator. The implant bed was prepared by the conventional drilling procedure. The predetermined dental implant size installed in its position. Soft tissue closure was achieved with 3/0 black silk non absorbable suture (simple interrupted technique).



**Figure 1: Placement of dental implants through the palatal bias incision**



**Figure 3: Drilling with pilot drill.**

**Flapless Procedure (Study Group)**

After anaesthetization with Lidocaine 2% by infiltration technique, the soft tissue punch was used with speed 400-600 rpm to remove the soft tissue and expose the bone in which the implant to be driven in as seen in Fig (2).



**Figure 2: Mucosa was punched by tissue punch.**



**Figure 4: Parallel pin to verify proposed implant angulation.**

The drilling procedure was started by pilot drill, Fig. (3), then the parallelism and angulation of drilling holes checked with parallel pins, Fig. (4)

followed by sequential stepped drilling until reaching the appropriate final drill size according to manufacturer instructions. The predetermined dental implant size installed in its position, Fig. (5), and the margin of implant checked by periodontal probe to ensure that it was with the level of the surrounding bone followed by subjoining the cover screw into the fixture, Fig. (6). Then a single 3/0 black silk suture was used to preserve blood clot above the implant area.



**Figure 5: Installation of dental implant in its position.**



**Figure 8: Final prosthesis was fixed in patient's mouth.**



**Figure 6: Fixtures after placement in prepared sockets with cover screws.**

After six months the patients re-attended for second stage surgery and placement of healing abutments for about (10-14) days, Fig. (7), then the patients were referred for prosthesis fabrication, Fig. (8).



**Figure 7: Healing abutment connection after six months.**

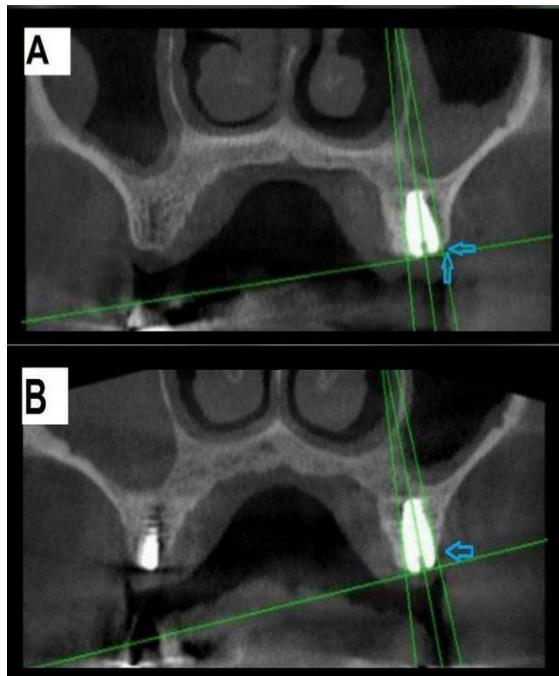
**Data Collection and post-operative Radiological Assessment**

All patients in both surgical groups were informed to take CBCT (time 1) in the same day or at the second day of surgery to assess the position of the implants within the bone; the relation of the implant/s to the other dentition, vital structures and the relation of the implant to the crestal bone level in 3 planes. Data were collected first at the seventh day after surgery (first follow up). Determination of bone level immediately that represents as base line data for each implant in both group on two sides, buccal side and palata/lingual side, firstly a vertical line was drawn at the center with the long axis of the dental implant passing through the notch of the cover screw which represent a reference point, then another horizontal line was drawn at the top of implant to determine its level with the crestal bone, also another two vertical lines along the buccal and palatal/lingual sides of implant were drawn where from these lines about 1mm the bone level was measured on each side of implant if the bone thickness was enough (such as implants placed in posterior area) or about 0.5 mm if the bone was thin (such as implants placed in anterior region), Fig. (9 A)

All the patients were investigated by CBCT (time 2) after 24 weeks post-operatively with the same relations of (time 1), also assessment of osseointegration, survival and early failure rate with the aid of Alberktson criteria of success (implant immobility, no peri-implant radiolucency, asymptomatic), and checking for any complication that may have occurred.

Determination of crestal bone level after 24 weeks was done with the same method in (time 1) and the difference was calculated which represented bone loss that was shown as a shadow in the area, Fig. (9 B). In order to view the same

section in the CBCT and to avoid any error that may affect the result in reading the section, the notch of the cover screw is used as a reference point.



**Figure (9):** CBCT (oblique view) for the same posterior DI placed with flapped procedure. (A) Immediate post-operative CBCT illustrating the buccal side bone level of DI (arrows) in relation to the horizontal line. (B) 24 weeks post-operative CBCT illustrating the difference in bone level (arrow) that presented as shadow.

**Statistical Analysis**

The data were analyzed using Statistical Package for Social Sciences (SPSS) version 25. The data presented as mean, standard deviation and ranges. Categorical data presented by frequencies and percentages. Independent t-test and Analysis of variances (ANOVA) (two tailed) was used to compare the continuous variables among study groups accordingly. Z-test was used to evaluate the difference in proportions between flapped and flapless cases regarding survival rate. A level of P – value less than 0.05 was considered significant.

**RESULTS**

There was **no significant** difference between study (flapless) and control (flapped) groups in the mean of total crestal bone resorption for buccal and palatal sides after 24 weeks from implant placement (P= 0.393 for buccal side and P= 0.214 for palatal side), Table (1). There was **highly significant** differences between buccal and palatal sides regarding crestal bone loss around implants measured by CBCT after 24 weeks from implants

placement for both flapped and flapless surgical techniques (P = 0.001), table (2).

**Table 1: Comparison according to total mean bone loss in buccal and palatal sides between two surgical groups.**

Sides	Total Bone Loss in Surgical Groups		P-Value
	Flapped Group Mean ± SD	Flapless Group Mean ± SD	
Buccal Side	0.5 ± 0.43	0.39 ± 0.35	0.393
Palatal Side	0.13 ± 0.18	0.06 ± 0.14	0.214

Values are expressed in mean ± SD

**Table 2: Comparison between Total Resorption of Buccal and Palatal sides**

Group	Total Bone loss of Buccal and Palatal Sides		P-Value
	Buccal side Mean ± SD	Palatal side Mean ± SD	
Flapped group	0.5 ± 0.43	0.13 ± 0.18	0.001
Flapless group	0.39 ± 0.35	0.06 ± 0.14	0.001

Values are expressed in mean ± SD

**DISCUSSION**

According to our data flapless surgery cannot fully avoid bone resorption this was true with all implants placed by flapless technique in this study as they were evaluated by CBCT. This agree with a study done by **Nickenig et al. (2010)** (22) , they found that the mean crestal bone loss of **(0.5 mm)** for implants placed with flapless surgery after a healing period determined radiographically using digital panoramic radiographs.

So it possible to say that gentle flap raising does not hamper bone healing around dental implants in humans. Based on the results obtained from this study, the choice of type of surgical approach does not affect peri-implant bone resorption.

Our data on bone resorption are in line with the majority of data in the literature, **Lin et al. (2014)** (23) reported no significant reduction of marginal bone resorption with flapless technique, also studies showed that crestal bone loss was comparable among implants placed either using flapped or flapless surgical technique (24, 25).

The findings of this study disagree with **Tsoukaki et al. (2013)** (8) who reported that no bone resorption around flapless implants and (**Job et al.,**

2008)<sup>(26)</sup> who reported a significantly lower resorption around implants in flapless group.

In this study, there was **significant** difference between total mean of buccal and palatal aspects (**P = 0.001**) for both flapped and flapless group. There was obvious that bone resorption in buccal side much more than palatal / lingual side in both groups. Also bone resorption in buccal side was a little higher in maxilla than mandible and anteriorly more than posteriorly for the flapped group, while for flapless group was nearly the same.

The data from this study can be accounted for the following reasons:

According to anterior maxilla the bone loss in buccal/facial side was higher than palatal side in both flapped and flapless groups, this may be related to the thinner facial plate that leading to more bone resorption after implant placement. This was supported by **EL Nahass & Naiem. (2015)**<sup>(27)</sup>, who reported that in the incisor region, the buccal bone plate around a tooth was thinner than 1 mm in 86% of the cases as demonstrated by Computerized tomography.

For posterior maxilla and mandible in flapless group also the bone loss was higher in buccal side than palatal/lingual side, there was no clear interpretation for this result but after evaluation of the buccal plates for implants placed with flapless procedures, we noticed that most of them were thinner than palatal/lingual plates, this may be either they were initially thin or implant were deviated slightly towards buccal side during placement which made them more thin. It however noteworthy that thin buccal plates lost more bone than thick buccal plates.

The deviation of implants supported by a study done by **Van de Velde et al. (2008)**<sup>(28)</sup> performed an in vitro model study to analyze deviations in the position and inclination of implants placed with flapless surgery compared with the ideal, virtual planned position and they concluded that location of implants installed with a flapless approach differed significantly from the ideal position.

The findings were supported or in line with a hypothesis reported by **(Teughels et al., 2009; Merheb et al., 2015)**<sup>(29) (30)</sup>, stated that a thin buccal plate is less resistant to the different types of trauma an implant can endure and would therefore be more prone to resorption and buccal implant exposition.

According to posterior maxilla and mandible in flapped group the buccal bone loss was higher than palatal/lingual bone, this may be related to the flap elevation during surgical procedure on the buccal side and subsequent trauma that occurred more buccally rather than palatal/ lingual sides where

there was no flap elevation. This was supported and in accordance with the fundamental studies reported by **Merheb et al. (2015)**<sup>(30)</sup>, who stated that flap elevation lead to a bone resorption from the surgical trauma of up to 0.4 mm.

**Conclusions:** Bone resorption around dental implants placed with conventional flap surgery compared to flapless surgery does not seem to be influenced during the healing period before implant loading. Bone resorption in buccal side facing dental implants compared to palatal side seems to be influenced in conventional flap and flapless surgery.

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## الخلاصة

**خلفية الدراسة:** زراعة الأسنان تعد بمثابة جنور الأسنان الاصطناعية حيث يتم تقييم بقائها على المدى الطويل من خلال تقييم كمية فقدان العظم السنخي الحافي حول زراعة السن. هناك سبب للأعتقاد بأن رفع السدلة الجراحية يعزز من فقدان العظم في المراحل الأولية بعد ادخال الغرسة. يتغير الوضع الجراحي لزراعة الاسنان بشكل مستمر وفي السنوات الاخيرة كان هناك بعض الاهتمام بتطوير التقنيات التي تقلل من طبيعة الأجراء الجراحي مع تزايد عملية الجراحة اللاسدلية. أن استخدام التصوير الشعاعي المقطعي المخروطي لقياس حجم العظم حول الغرسات السنوية والارتفاع بين منصة الغرسة وبداية الغرسة مع العظم يمكن أن يكون مفيدا جدا ومهما لمراقبة الأنسجة العظمية للحفاظ على طول عمر الزرعة وجمالية الأسنان الاصطناعية المدعمة بالزرعات.

**أهداف الدراسة:** لمقارنة المستوى الشعاعي للعظم المحيط بالزرعة بين عملية الجراحة التقليدية (السدلية) والجراحة (اللاسدلية) اعتمادا على التصوير الشعاعي المقطعي المخروطي خلال فترة الشفاء (24 أسبوع). أيضا لاجراء مقارنة عامة بين كل من التقنيات فيما يتعلق بمدة العملية الجراحية.

**المواد وأساليب العمل:** أجريت هذه الدراسة الاستباقية السريرية من كانون الاول/ديسمبر 2017 الى تشرين الثاني/نوفمبر 2018, وان ما مجموعه 25 مريضا عراقيا مع 47 عملية زرع تتراوح اعمارهم بين 20 و 60 سنة. فشلت عملية زرع واحدة في المجموعة الضابطة لذلك تم استبعادها من التحليل الاحصائي باستثناء تحليل معدلات البقاء والفتش. تم اختيار المرضى بصورة عشوائية في مجموعتين: المجموعة الضابطة التي تضمنت 27 عملية زرع يتم ادخال الزرعات عن طريق الجراحة التقليدية (السدلية) ومجموعة الدراسة تضمنت 19 عملية زرع تم ادخال الزرعات عن طريق الجراحة (اللاسدلية) حيث تم تقييم سريري وشعاعي قبل الجراحة لجميع المرضى وتم اجراء تقدير العظم السنخي لمجموعة الدراسة عن طريق التخطيط العظمي. تم استخدام نظام زرع واحد في الدراسة (شركة Nucleoss , تركيا) وتم قياس مستوى العظم (الخسارة) ومدة العملية لكل زرعة. قياس مستوى العظم تم بواسطة التصوير الشعاعي المخروطي بجهاز (Carestream CS 8100 3D Health Inc., France) في الجانب الخدي والجانب الحنكي مرتين لكل زرعة, فور وضع الزرعة وبعد فترة الشفاء (24 اسبوع).

**النتائج:** لم يكن هناك فرق معنوي بين مجموعة الدراسة ومجموعة الضبط في متوسط اجمال فقدان العظم في الجانب الخدي والحنكي (  $P=0.393$  ) للجانب الخدي و (  $P=0.214$  ) للجانب الحنكي. كانت هناك فروق ذات دلالة احصائية كبيرة بين الجانب الخدي والحنكي فيما يتعلق بفقدان العظم حول الزرعات التي تم قياسها بواسطة التصوير الشعاعي بعد 24 اسبوع من وضع الزرعات لكل من التقنيات الجراحية (  $P=0.001$  ). وفقا لوقت العملية, استهلكت زراعة السن في مجموعة الدراسة حوالي ثلث الوقت اللازم لزراعة المجموعة الضابطة مع فرق كبير للغاية (  $P=0.001$  ).

**الاستنتاجات:** لا يبدو ان فقدان العظم حول الغرسات السنوية الموضوعة بطريقة الجراحة (السدلية) مقارنة بالجراحة (اللاسدلية) قد تآثر خلال فترة الشفاء قبل تحميل الزرعة.