Evaluation of marginal bone loss around SLActive implants by CBCT using different implant dimensions and surgical approaches: A clinical and radiological prospective study

H. B. M. ALMAYAH[1], T. A. HASSAN[2], H. A. AL-JUMAILY[2], Z. H. AL-GHURABI[3]

[1]Department of Oral and Maxillofacial Surgery, College of Dentistry, Almustansyria University, Baghdad, Iraq
[2]BDS, H.D.D, FIBMS, Prof., Oral and Maxillofacial Surgery Department, Dental Teaching Hospital, College of Dentistry, University of Baghdad, Bab-Almoadham, Baghdad, Iraq
[3]BDS, FIBMS, Assist prof., Oral and Maxillofacial Surgery Department, Dental Teaching Hospital, College of Dentistry, University of Baghdad, Bab-Almoadham, Baghdad, Iraq
[4]BDS, MSc, Assist prof., Oral and Diagnosis Department, Dental Teaching Hospital, College of Dentistry, University of Baghdad, Bab-Almoadham, Baghdad, Iraq

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ABSTRACT

Aim The reduction in the amount of marginal bone is the most important demand for the long term success of dental implants. This prospective clinical study was aimed to investigate the marginal bone loss of early loaded SLActive implants with different dimensions and surgical approaches.

Materials and methods Fifteen patients aged from 18 to 60 years were divided into 2 groups (flapped and flapless approach) that underwent delayed implant placement protocol with SLActive implants. The marginal bone level was estimated by cone-beam computed tomography during three different periods: preoperatively, 8 weeks after surgery and 24 weeks after loading of the prosthesis.

Results The mean value of marginal bone level was not significantly changed 8 weeks after surgery and 12 weeks after loading of the prosthesis when compared with baseline data in both flapped and flapless approach. Bone level was significantly decreased with dental implant dimension Ø 4.1 mm RC, length 12 mm.

Conclusion The results demonstrated that marginal bone loss is affected by many factors, such as age of the patient, and dental implant dimension.

INTRODUCTION

Computed tomography (CT) was developed in 1972, and reported in 1973 in the British Journal of Radiology as able to diagnose conditions with 3-dimensional (3D) images. This device was used in many fields and its use in dentistry became more frequent with the advent of implant surgery (1). Each cone-beam computed tomography CBCT system has different features, including field of view, voxel size, patient positioning system and imaging durations, which affect the diagnostic image quality, noise, high and low contrast resolution and artifacts (2). CBCT has many advantages such as multiplan reconstruction, adequate for bone grafting assessment, and computer aided surgery. Disadvantages include limited soft tissue visualization, limited measurement of bone density and additional expense for third-party software applications and 3D models (3). The chemically modified sandblasted, large-grit and acid-etched surface (SLActive) of dental implants was developed in 2005 by means of rinsing them under protective N2 conditions and storage in isotonic NaCl solution, which leads to improved surface chemistry and greatly increases the hydrophilic properties which have approximately 60% greater bone formation than SLA implants (4). This contamination-reducing storage method allows the SLActive implant to have higher surface energy and greater bone-implant contact at 2 and 4 weeks when compared with SLA. This specific production method of SLActive implant is aimed to create a chemically active surface with a small number of hydrocarbons and carbonates, which determines its immediate wettability and ultra-hydrophilic character. Owing to SLActive implant potential for enhancement of bone formation, it has excellent outcomes in many clinical situations such as early loading in the posterior mandible and maxilla with simultaneous maxillary sinus augmentation, osteotomy sinus floor elevation, poorly controlled diabetes, and patients who had previously undergone therapeutic irradiation (4,5).
Dental implants placement is based on a concept of surgery with flap elevation. The first incisions followed the protocol designed by Brånemark, performed in the

oral vestibule and mucosa, so when the flap was replaced, the incision line and suture remained separated from the location of the implant, in order to prevent the infection of the surgical area (6). The flapped approach allows better visualization particularly in areas of inadequate bone quantity, permits the manipulation of soft tissue in aesthetic regions, prevents ingrowth of gingival tissue between the implant and the bone (7), reduces the risk of bone fenestrations or perforations (8) and allows for some anatomical landmarks to be clearly identified and protected (9). Disadvantages include periosteum disruption, blood vessels damage, leading to sub-periosteal hemorrhage, edema and swelling that can develop beneath the flap which is accompanied by hematoma, incision line opening (dehiscence of the wound), decrease of the body's defence mechanism against bacteria (10) and patient discomfort which includes pain, bleeding, edema and longer surgical time (11). Traditionally, the flapless surgical approach was already introduced in the late 1970s by Ledermann. This approach requires no mucoperiosteal flap reflection while placing the dental implant and therefore, the consequent trauma of peri-implant tissues is smaller (12). It includes many categories (free hand technique, guided surgery with and without three dimensional navigation). This approach has multiple limitations such as a blind technique, impossibility of evaluating and treating bone defects (6), risk of damaging anatomic structures, poor control of precise drilling depth (7) and difficulty in maintaining keratinized gingiva (8). It has many advantages, such as early bone remodeling process (13), reduced surgical time (11), faster healing of soft tissue, reduction of bleeding, high survival rates (6,12).

MATERIALS AND METHODS

This clinical prospective study was done in the College of Dentistry/ University of Baghdad between November 2018 and November 2019, included 15 healthy eligible patients (aged from 18 to 60 years) selected as straightforward cases for delayed DI placement protocol in the maxilla or mandible. These patients were allocated in 2 groups: flapped and flapless (Table 1). Marginal bone loss was measured at the time of surgery (1st), 8 weeks (2nd) and 24 weeks after surgery (3rd). Preoperative clinical and radiographical measurements were done for all patients who met the inclusion criteria. An initial orthopantomogram was taken to measure the height of the bone taking into consideration the amount of magnification and important anatomical structures.

Surgical Approach	Number of DI	%
Flapped	24	48
Flapless	26	52
Dimension (mm)		
4110 ø 4.1 mm - l. 10 mm	16	32
3312 ø 3.3 mm - l. 12 mm	9	18
4112 ø 4.1 mm - l. 12 mm	8	16
3310 ø 3.3 mm - l. 10 mm	6	12
4108 ø 4.1 mm - l. 0.8	5	10
3308 ø 3.3 mm - l. 0.8	4	8
4810 ø 4.8 mm - l. 10 mm	2	4

TABLE 1 Descriptive statistics of the study sample (surgical approach and dental implant dimension).

Inclusion criteria

Patients with good general health without any disease compromising bone healing potential, patients of both genders aged 18-60 years, partially edentulous maxilla or mandible eligible for delayed implant placement protocol (6 months after teeth extraction), and straightforward cases according to SAC classification.

Exclusion criteria

Patients with systemic conditions that interfere with normal healing or inability to withstand surgery including pregnancy at the time of the surgical procedure, psychosis or unrealistic expectations, uncontrolled systemic diseases like uncontrolled diabetes, irradiation of the head and neck region or chemotherapy over the past 5 years, local conditions such as the presence of acute/chronic infection or local pathological conditions in the implant zone, active periodontitis and poor oral hygiene, advanced and complex cases according to SAC classification, and parafunctional habits (bruxism or clenching).

Surgical procedure

At the time of surgery local anesthetization of the planned surgical field in both groups was achieved with Lidocaine 2% (Septodont, Lancaster, PA). The first clinical measurement was done for bone width by using sterile bone caliper 3 mm apical to the crest.

In the flapped group, a two or three-sided flap was made initiating via a crestal incision with palatal\lingual side for better visibility and sequential drilling was accomplished first with pilot drill to the predetermined height then the preparation of the implant bed was done with spiral drills of increasing diameter with copious normal saline irrigation and sequential drilling technique according to implant system recommendations.

For the flapless group, the surgical procedure was started by using a rotary tissue punch, 4 mm in diameter, with the speed of 800 rpm to core out the gingiva and expose the bone for implant insertion, and the same drilling, sequence was followed for the flapped group. The dental implant (Institute Straumann AG, Switzerland) with SLActive surface was installed. Finally, wound closure

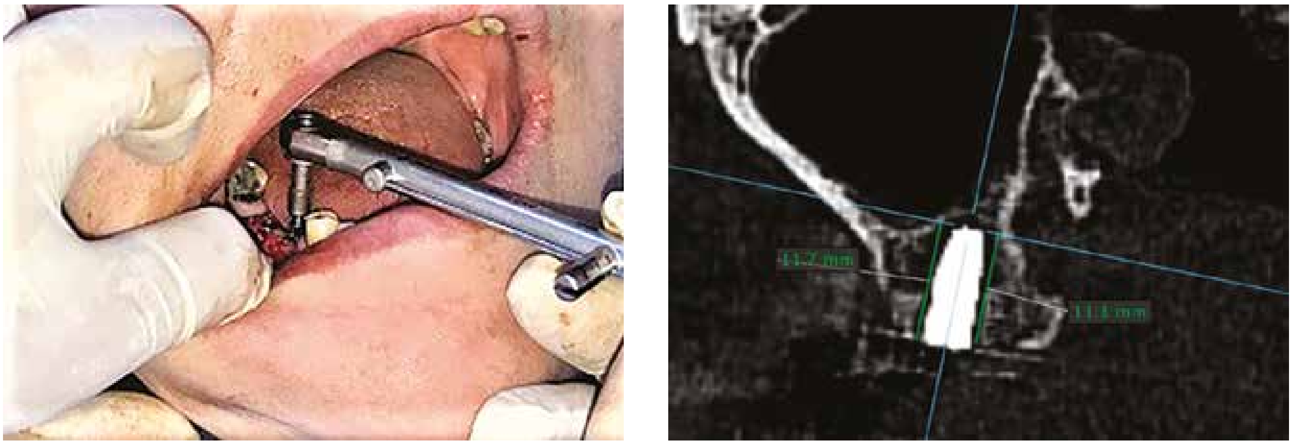

FIG. 1 A: Placement of the implant with the level of the bone. B: Sagittal view of CBCT to evaluate the bone level as a baseline of the tooth site # 15.

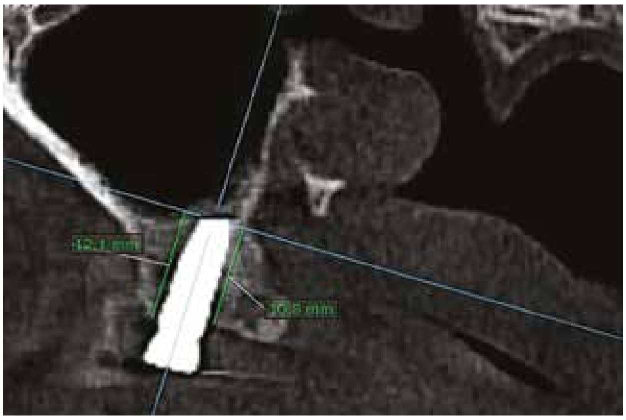

FIG. 2 A: Sagittal view of CBCT demonstrating the marginal bone level after 8 weeks of healing period of the tooth site # 15. B: Placement of the prosthesis after 8 weeks of surgery.

was performed with 3-0 black silk sutures.

Postoperative measurements

All patients were examined immediately on the same day after surgery through CBCT (KAVO OP 3D; Germany) to assess the marginal bone level as a baseline. Two views (coronal & saggittal) utilized in the determination of this level around the implant by the determination of the central point of the apical and coronal part of the implant. Subsequently, the software calculated with three-dimensional rotation and constructed horizontal planes perpendicular to the long axis of the implant. This resulted in four circumferential measurements buccomesial, linguomesial, buccodistal, linguodistal from the apical part of the implant to the margin of the crest (Fig. 1).

Follow-up

In the first follow-up appointment, the patients were informed to come back 8 weeks postoperatively after taking CBCT for evaluation of the marginal bone loss and prosthesis fabrication (Fig. 2A, 2B).
Motorized tissue punch (Dentium) was used to core out the overlying mucosal tissue and expose the implant. The healing abutments left in situ for 7 to 10 days. The prosthesis was fabricated and cemented temporarily in

VARIABLE	1ST MEAN	2ND MEAN	P-VALUE	3RD MEAN	P-VALUE
FLAPPED	10.17±1.48	10.03±1.4	0.511 NS	9.77±1.4	0.341 NS
FLAPLESS	10.55 ± 1.1	10.45 ±1.1	0.271NS	10.6 ± 1.2	0.759 NS

S, Significant, NS, nonsignificant

TABLE 2 Determination the marginal bone level changes with each variable.

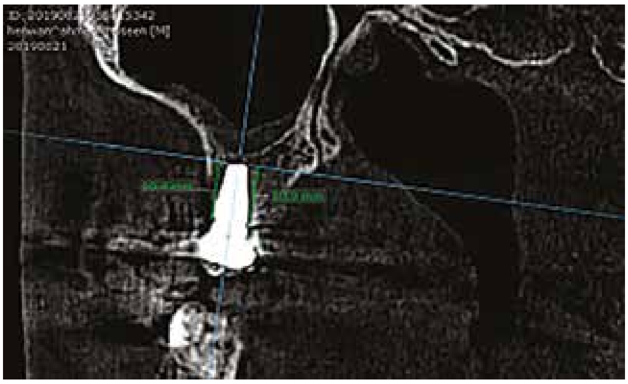

FIG. 3 Sagittal view of CBCT illustrating the marginal bone level 24 weeks after loading of the prosthesis.

the patient mouth.

In the third follow-up, after 24 weeks, the patient underwent another CBCT to measure marginal bone level after this period (Fig. 3).

Statistical analysis

Data description and analysis were performed using computer program Statistical Package for Social Sciences (SPSS version 25). An independent sample paired t test was used to test these data. Not significant at $P > 0.05$, significant at $P < 0.05$, highly significant at $P < 0.01$.

RESULTS

Fifteen patients were included in this study: 10 females (66.7%) and 5 males (33.3%) with a mean age of 45.6 ± 11.8 years. They underwent delayed placement protocol and received 50 SLActive implants divided into two groups, flapped and flapless (24 and 26 subjects respectively), with follow-up 8 and 24 weeks after surgery. There was no significant difference in the 2nd and 3rd measurements of marginal bone loss when compared with 1st measurements with the flapped and flapless approach as illustrated in Table 2. The mean of the bone level was significantly decreased after 8 weeks with an implant with diameter 4.1 mm and length 12 mm. On the other hand, there was no significant change with other implant dimensions (Table 3).

DISCUSSION

There was a significant decrease in the level of the bone at the 2nd measurement in patients aged ≥ 40 and female gender, while the 3rd CBCT measurement was significantly decreased in patients aged ≥ 40 with no significant changes in both genders. This is in agreement with many clinical studies, namely Negri et al. (14) and Chrcanovic et al. (15), reporting that postmenopausal women undergo a rapid and significant decline in bone mass. The results in the present study illustrated a non-significant change in marginal bone level between the flapped and flapless procedure in the 2nd and 3rd measurements (Table 2). The explanation may be borrowed from Karabuda et al. (16), who demonstrated that the reduced marginal bone loss around SLActive implants during the loading stage may be related to the enhanced osseointegration characteristics of hydrophilic SLActive implant surface. There was a significant decrease in the second measurement with implants with diameter 4.1 mm and length 12 mm. In contrast, there was no significant change in the 3rd measurements for all dental implants (Table 3). There is no convincing explanation for these results, since the number of dental implants with the dimension utilized in this study was 7, which when statistically analyzed is non-significant. This interpretation corresponds with that of Ganeles et al. (17), who concluded that at 12 months post surgery there is a significant correlation between bone level and SLActive implant length and position. Also, Negri et al. (14) claimed that a larger implant diameter in the maxilla has higher marginal bone loss than smaller platforms. The current study registered a total implant survival rate of 94%. The total survival rate was close to other clinical studies (4,16,18) despite differences in follow-up periods and sample size.

CONCLUSION

When compared with the initial baseline data, the results revealed no significant change in marginal bone level at

Dimension	1st mean	2nd mean	P -value	3rd mean	P -value
33 12	11.6 ± 0.2	11.85 ±0.3	0.167	11.5 ± 0.3	0.213
33 10	10.14 ± 0.6	9.9 ± 0.4	0.287	9.7 ± 0.6	0.243
33 08	7.6 ± 0.1	7.8 ± 0.05	0.314	8.0 ± 0.01	0.101
41 12	11.95 ± 0.5	11.5 ± 0.6	0.028 S	11.8 ± 0.6	0.68
41 10	9.95 ± 0.3	9.8 ± 0.3	0.089	9.9 ± 0.5	0.722
41 08	7.94 ± 0.2	7.7 ± 0.7	0.566	7.5 ± 0.4	0.134

S, Significant

TABLE 3 The effect of dimension on marginal bone level changes.

the second and third measurements with the different surgical approaches although, these were decreased in marginal bone level with dental implant with diameter 4.1 mm and length 12 mm during the 2nd follow-up period. The study demonstrated that the marginal bone level is affected by many factors (age of the patient ≥ 40, dental implant dimension).

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