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Evaluation of Single Drilling Technique on Osseointegration and Stability of Dental Implant in Type IV Bone Density

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ORIGINAL STUDY

Evaluation of Single Drilling Technique on Osseointegration and Stability of Dental Implant in Type IV Bone Density

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Abstract

Purpose: The present study was conducted to evaluate the effect of single drilling technique on stability and osseointegration of delayed dental implant in type IV bone density. **Subjects and methods:** The current study was performed on twelve (12) healthy patients that were divided randomly into two groups: Group 1 (Test group) included six (6) patients with delayed implant insertion using single drilling technique; Group 2 (Control group) included six (6) patients with delayed implant insertion using the conventional sequential drilling. **Results:** A non-statistically significant difference was recorded in clinical parameters after 6 months of follow-up in both groups. Test group demonstrated a highly significant increase in primary stability and its bone density after 6 months in comparison with control group. **Conclusion:** The use of single drilling technique in type IV bone density appears to have a promising result in increasing primary implant stability and promoting osseointegration.

Keywords: Dental implants, Osseointegration, Single drilling

1. Introduction

Dental implants are really a prevalent therapeutic modality for patients who have lost teeth, since they provide esthetics, function, mastication, as well as speech solution [1]. Dental implants are thought to be a more successful oral rehabilitation alternative [2]. Implant dentistry entails a prosthetic procedure that include a surgical process prior to treatment; the prosthetic portion should be planned to ensure that the best possible prosthesis is created [3]. The position and number of implants required to maintain a prosthesis are influenced by the quality and quantity of bone in various areas [4] as well as the size of the prosthesis [5].

Because of its superior mechanical and physical properties, titanium is the most commonly utilized dental implant material presently [6], depending on the material used in dental implant manufacturing [7]. Titanium is currently the material of choice for dental implant fabrication due to a variety of beneficial features, including its excellent biocompatibility [8].

Osseointegration is a process that creates a strong, long-lasting bond between the implant and the surrounding bone tissue, which is essential for implant longevity. In the absence of osseointegration, biological failure would occur, resulting in implant failure [9]. Immediately after implant placement enough primary stability should be achieved through the mechanical retention of the implant into the surrounding bone, which provides an essential mechanical microenvironment for the gradual establishment of bone healing and osseointegration [10].

In recent years, Resonance Frequency Analysis (RFA) has become one of the most extensively utilized methods for evaluating implant stability in clinical practice. The reaction of an implant-

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attached piezo-ceramic element to a vibration stimulus consisting of tiny sinusoidal signals in the 5–15 kHz range, in steps of 25 Hz on the other element, is used to perform RFA. The implant stability quotient (ISQ), which spans from 0 to 100, is then used to encode the peak amplitude of the response [11].

A thin cortical bone with a core of lesser density trabecular bone (type IV bone density) [12]. Adequate primary stability may be difficult to achieve at this point. As a result, changes to the drilling technique or the implant's macro design are recommended [13].

In cases where there is inadequate bone availability, both in terms of quantity and quality, surgical and/or regenerative techniques may be required prior or with implant placement [14]. The surgical procedure has a significant impact on the implant's durability and success. During the drilling of the osteotomy site, which is done with a series of surgical drills to establish an implant bed that fits the implant perfectly, a significant amount of bone tissue is sacrificed. Several improvements to implant surgical procedures have been proposed in order to achieve a high level of implant stability without removing extra bone, particularly in circumstances when bone density is restricted [15].

Sequence and speed of drilling in implant surgery have long been known to have an impact on implant placement. A basic principle has been considered a gradual drilling sequence in the creation of the implant placement location. Using many drills, on the other hand, takes time, which has resulted in a number of drawbacks, including patient discomfort and an increased risk of infection [16].

The 'undersized drilling' technique, which relies on lateral bone compression along the implant's sides by using a final drill diameter, is one of the surgical techniques used to improve osseointegration in low-density bone. As a result of this approach, high insertion torque values are achieved, which improve primary implant stability [17]. A recent study confirmed that the use of minimally traumatic bone drilling is strongly recommended in order to preserve as much bone tissue as possible while preserving its healing ability [18].

Recently an in vivo study was performed to investigate the consequence of using single drill in preparing the implant bed in low bone density (in cancellous type IV bone). The results showed that this procedure demonstrated many clinical and histological advantages, including higher bone-to-implant contact, high implant stability, elevated patient comfort and fewer cost [16].

2. Subjects and methods

2.1. Study design

This study was a randomized clinical trial on 12 patients selected from the out-patient clinic of Oral Medicine & Periodontology Department, Faculty of Dental Medicine for Girls, Al-Azhar University. The study was approved by the Research Ethics Committee of Faculty of Dental Medicine for Girls, Al-Azhar University (REC-ME-22-02). Prior to any procedure, all subjects were informed about the nature and benefits of their participation in the study. All patients provided satisfactory written consents indicating their comfort with the planned research program and study design.

2.2. Sample size

Sample size calculations achieved using http://biomath.info/power [19]. A total sample size of 12 patients (6 patients in each group) was enough to identify the difference. Total number of patients were divided randomly into two groups; Group 1 (Test group): 6 patients with delayed implant placement using a single drilling technique. Group 2 (Control group): 6 patients with delayed implant placement using the conventional sequential drilling.

The patients were selected according to selected criteria (completely healed surgical site, presence of proper interarch space for the placement of the implant prosthetic part, D4 bone density, nonsmoker, and nonpregnant women).

2.3. Surgical protocol [16]

After local anesthesia administration, crestal incision at the edentulous site with sulcular incisions around mesial and distal natural tooth were performed. Full thickness flap was elevated using the mucoperiosteal elevator.

Regarding control group (Group 2), osteotomy site preparation through sequential drilling Dentium super line implant system (Emergo Europe, Seoul, Korea) was used in this study until reaching the desired diameter of the implant under copious saline irrigation, then the implant screwed in a clockwise manner until complete seating of the implant to its final insertion depth. Primary stability was assessed using a smart peg and ostell device (Ostell AB, Goteborg, Sweden). Flap was returned to its position covering the implant and sutured with 4-0 polypropylene suture material. Regarding test group (Group 1), the same steps were followed, but,

osteotomy site prepared by pilot drill followed by counter sink, then the implant inserted and screwed within its place, primary stability measured, and cover screw was placed, return the flap and finally suturing. Augmentin 1 g tablet antibiotic (625 mg Amoxicillin trihydrate, 125 mg Clavulanc acid, GSK, Egypt) was prescribed twice per day for 5 days after surgery, Ibuprofen 400 mg tablet (Kahira CO. for Pharma and Chemo., IND Company, Cairo, Egypt) was prescribed every 8 h for 3 days postoperative as analgesic and anti-inflammatory, Chlorhexidine 0.12% mouthwash (Kahira CO. for Pharma and Chemo., IND Company, Cairo, Egypt) was prescribed twice daily for one week after surgery. Sutures were removed 10 days postoperatively. Five months after surgery, the cover screw of the implant was removed, and the gingival former was placed.

2.4. Clinical evaluation

(1) Modified Gingival index (MGI): was recorded for each patient at 6 months after implant placement.
(2) Probing depth (PD): it was obtained by measuring the probing pocket per site around the implant. Probing depth is measured from the gingival margin to the base of the sulcus. Probing depth was recorded at 6 months for each patient around the healing abutment.
(3) Primary implant stability: was recorded immediately after implant insertion using ostell device.

2.5. Radiographic assessment

(1) Cone beam computed tomography (CBCT) was used twice before fixture placement and at the end of the study (after 6 months) to record bone density (Fig. 1).
(2) Bone density was taken for the coronal view. Two lines were drawn along the total length of the implant fixture (buccal and palatal of coronal view) and then each line divided into three parts, representing the coronal, middle and apical thirds. Measurements were taken from around ~1 mm in a parallel way away from the implant fixture to avoid titanium artifact at the bone–implant interface. Then these six readings were divided by six to get the mean value of bone density around each implant in each view. The readings were recorded in Hounsfield Units (HU) [20].

3. Results

Data were collected, revised, coded and entered to the Statistical Package for Social Science (Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, New York: IBM Corporation). The quantitative data were presented as mean, standard deviations and ranges, while qualitative data were presented as number and percentages. The comparisons between groups with qualitative data were done by using the Chi-square test while the comparison between two groups with quantitative data and with parametric distribution were done by using the Independent *t*-test, while with non-parametric distribution were done by using the Mann–Whitney test. The comparison between two paired groups regarding quantitative data with parametric distribution were done by using Paired *t*-test.

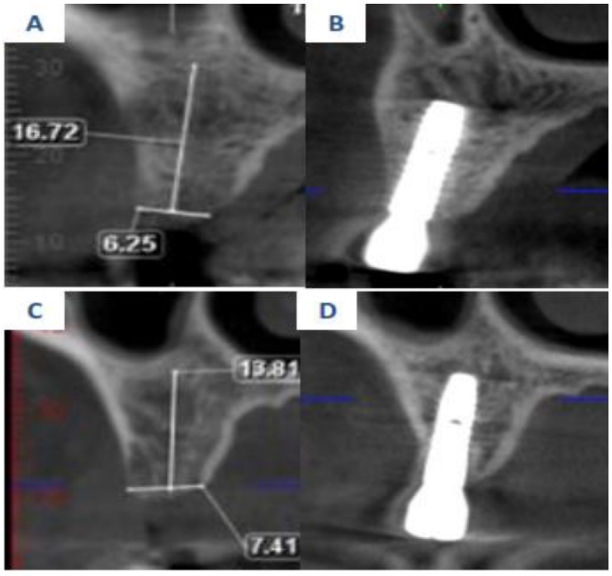

Fig. 1. ***Radiographic follow-up.*** ***A:*** *Preoperative CBCT of implant site test group* ***B:*** *Six-month CBCT postoperative test group* ***C:*** *Preoperative CBCT of implant site control group* ***D:*** *Six-month CBCT postoperative control group. In postoperative CBCT test group, the bone appears densified around the implant in comparison with the postoperative CBCT of the control group.*

3.1. Clinical evaluation results

(1) There was no statistically significant difference found between control group and the test group regarding the mean of MGI and mean PD 6 months postoperative with P value < 1.000 (Table 1).
(2) There was a highly statistically significant increase in primary implant stability in the test group than the control group with a P value < 0.001 (Table 1).

3.2. Radiographic assessment results

(1) Before implant insertion; the control group and test group readings were 243.67 ± 27.38 and

Table 1. Results of MGI PD at 6 months and primary implant stability of both groups through the study period.

	Control group No. = 6	Test group No. = 6	Test value	*P* value	Sig.
Mean MGI at 6 months					
Mean ± SD	0.08 ± 0.13	0.08 ± 0.13	0.000•	1.000	NS
Range	0–0.25	0–0.25			
Mean PD at 6 months					
Mean ± SD	0.75 ± 0.27	0.75 ± 0.27	0.000•	1.000	NS
Range	0.5–1	0.5–1			
Primary implant stability					
Mean ± SD	50.17 ± 1.33	64.00 ± 4.20	−7.700≠	0.000	HS
Range	48–52	58–69			

$P > 0.05$: Nonsignificant, $P \leq 0.05$: Significant, $P \leq 0.01$: Highly significant.

271.83 ± 15.82, respectively. This statistically was with nonsignificant difference with $P = 0.054$ (Table 2).

(2) At 6 months after implant insertion; the control group and test group readings were 531.00 ± 21.78 and 894.50 ± 109.22, respectively; this statistically was with highly statistically significant with $P = 0.000$ (Table 2).

(3) There was highly statistically significant increase in the mean change of test group than control group with a P value < 0.001 (Table 2).

4. Discussion

The aim of this study was to evaluate the clinical and radiographic effects of a single drilling technique in type IV bone density in order to enhance dental implant outcomes in patients with poor bone quality. Thus, the use of a single drill technique is less aggressive and may possibly promote ossoeintegration. Furthermore, using a single-step method improves the precision of implant site preparation [21].

In the current study, implant stability was assessed by the Resonance Frequency Analysis (RFA) via ostell ISQ system immediately after implant insertion. RFA is a noninvasive and reliable method to evaluate variation in implant stability. RFA registration are directly related to the rigidity of the implant in the surrounding bone [22]. Clinical measures (Modified Gingival index and probing depth), as well as radiographic assessment, were used to assess dental implants [23]. As regards, modified gingival index is a measurement that is used to express disease activity [24]. On the other hand, the probing depth index is a key index for diagnosing peri-implant disease [25].

The good results of MGI and PD in this study can be attributed to adequate patient motivation and proper oral hygiene.

Plaque accumulation was well controlled throughout the course of the study by using 0.12% Chlorhexidine mouthwash for bacterial load reduction commencing a day before surgery and continuing for 2 weeks surgery [26].

Regarding primary implant stability, there was a highly statistically significant increase in primary implant stability in test group than control group with P value < 0.001. This in agreement of another study [21] that stated that the implant site preparation by single-step drill resulting in increased primary stability.

About bone density results, before implant insertion, no statistically significant was found between the two groups ($P = 0.054$), while there was highly statistically significant difference ($P = 0.000$) 6 months after implant insertion. These findings of improved bone around the dental implant and enhance bone density in test group were in line with

Table 2. Results of bone density (coronal view) changes of both groups through the study period.

Mean bone density (Coronal view)	Control group No. = 6	Test group No. = 6	Test value≠	*P* value	Sig.
Before implant insertion					
Mean ± SD	243.67 ± 27.38	271.83 ± 15.82	−2.182≠	0.054	NS
Range	203–277	251–292			
6 months after implant insertion					
Mean ± SD	531.00 ± 21.78	894.50 ± 109.22	−7.995≠	0.000	HS
Range	505–568	810–1065			
Mean change					
Mean ± SD	287.33 ± 47.28	622.67 ± 114.37	−6.637	0.000	HS
Range	228–365	518–810			

$P > 0.05$: Nonsignificant, $P \leq 0.05$: Significant, $P \leq 0.01$: Highly significant.

a study done in 2020 [19] that concluded that the use of single drill in implant site preparation significantly increased the peri-implant bone density compared to starting host bone density.

4.1. Conclusion

Within the limitations and finding of the present study, it could be concluded that the use of a single drilling technique in type IV bone density appears to have a promising result in increasing primary implant stability and improve bone quality around dental implants as it increases bone density, thus improving implant osseointegration which leading to a good prognosis.

4.2. Recommendation

Further investigations into the use of single drilling technique with dental implant with longer follow-up periods are needed.

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Conflicts of interest

None declared.

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