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Piezoelectric Device versus Conventional Rotary Instruments in Implant Site Preparation (Comparative Clinical Study)

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ABSTRACT

Purpose: This study was designed to evaluate and compare the efficiency of piezoelectric device for implant site preparation clinically and radiographically. **Materials and methods:** The study included 12 patients divided into two groups. The group A received implants prepared with the conventional drills (CDs), while, group B, the piezoelectric devices (PEDs) were used. The stability of implant was measured, immediately, at 2 months, and 4 months after the implant insertion. Also, the drilling time was recorded. While, the Marginal bone loss (MBL) and Bone mineral density (BMD) were recorded immediately, at 3, and 6 months after implant insertion. **Results:** Group B had a significant higher ISQ values all over the follow up periods. The drilling time of ISP was significantly higher in group B. Regarding the MBL, there was no a statistical significantly difference. The BMD increased significantly in group B immediately, and at 3 month. **Conclusion**: The osseointegration of implants prepared with PED was significantly greater than that of implants which prepared with the CDs all over the time points, but the PEDs need significantly longer surgical time than the CDs.

KEYWORDS

CDs, PEDs, Implant stability, ISP.

INTRODUCTION

A successful osseointegration of dental implants depends on several factors that include the design of dental implant, bone quality, and the stability of dental implant. Also, the implant site preparation (ISP) with a minimal damage to the surrounding tissues is particularly important to provide the successful osseointegration [(1)]. The implant site preparation (ISP) has been traditionally performed by using surgical

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drills of various designs which are confined to the geometry of dental implant and follow a specific drilling sequence [2]. The use of conventional drills (CDs) still is the standard method in ISP. However, their use may cause a mechanical trauma or thermal damage that leads to osteonecrosis, failure of the osseointegration and subsequent loss of dental implant [3].

One of the alternative drilling methods that have been reported to overcome the drawbacks of CDs is the ultrasonic drilling of bone depending on the piezo electric cavitation, which decreases the tissue injury during ISP [4]. The first design of the piezoelectric device (PED) was introduced for open sinus lift [5]. After that, PEDs have been used in several applications such as, ridge splitting, inferior alveolar nerve lateralization, and surgical extraction of teeth with minimal damage to adjacent tissues [6].

Despite the wide uses of PEDs, there are few studies that evaluate the use of PED for ISP in the aesthetic zone. Therefore, this prospective coherent study was enrolled to answer the following questions: 1) Does the use of PEDs have an impact on the osseointegration of dental implants? 2) To what extent will the PEDs affect the mechanical and biological stability of dental implants?

MATERIAL AND METHODS

Study design and sample

A prospective comparative study was implemented to address the purpose of the present study. The patients were divided into two groups. The group A received implants which their beds were prepared with the CDs, while, Group B, the PEDs were used.

Inclusion and exclusion criteria

The patients who fulfilled the following criteria were included in the study: 1) A missing upper anterior teeth or premolars, and 2) A presence of healthy gingiva around the surrounding dentition. The exclusion criteria were: 1) Patients who are suffering from any systemic diseases that compromise the implant osseointegration, and 2) The presence of an insufficient ridge width that needs augmentation procedures.

Predictor variables

1. ***The Primary Predictable Variables*** were the patients 'ages, sex, the tooth to be replaced, ridge height and width, and bone density measurements
2. ***The Secondary Predictable Variables*** were the effect of the CDs and PEDs on osseointegration and implant stability

Study's Outcome Variables

1. The surgical outcome variables were **a)** the primary implant stability at the base time of surgery. **b)** Drilling time
2. The clinical and the radiographic outcome variables **a)** the secondary implant stability at 2 and 4 months postoperatively. **b)** MBL at 3 and 6 months. **c)** BMD at 3 and 6 months after implant insertion

Data Collection

Preoperative Cone Beam Computed Tomography (CBCT) was requested to determine **the width and height of the ridge**. Also the **Bone Mineral Density** was measured by using a virtual implant of the same type and dimensions that was chosen from the implant list of the software and was placed at the proposed site of the implants preoperatively.

Implant stability: By using Osstell Mentor, the implant stability was assessed and followed over the follow up period. The ISQ values: were measured at the base time, the second, and the fourth months after implant insertion.

Drilling time :the surgical time from the first perforation of the cortical bone to the moment at

which the implant reached the final position was registered.

Marginal bone loss: The average of MBL was calculated by subtracting the marginal bone height immediately after implant insertion and the MBH at 3 and 6 months. **Bone mineral density:** The mean of BMD was also recorded at 3 and 6 months after implant insertion.

Surgical procedures

Local anesthesia was achieved by using nerve block and infiltration techniques. A 3 line pyramidal flap was made. **In the group A**, the implant site was prepared with the conventional drills. The drilling protocol was performed according to the manufacturing instructions. **In the group B**, the ISP was performed by using the piezoelectric device according to the manufacturing instructions. The preparation was started with; SG15B insert that was used as a pilot osteotomy reached the planned working length. Then, the preparation continued with SG16B insert for enlargement of osteotomy site to accommodate the next insert, which was the SCL2D used for further enlargement and expanding the ISP when approaching from the alveolar crest. This was followed by SCL3D used for adjustment of the ISP. Once the ISP was completed, the implant was transferred using implant mount and inserted into the prepared site, and finally, the cover screw was tightened by using the hex driver.

Statistical Analysis

Comparison of numerical variables between the study groups was done using Mann Whitney U test for independent samples. Within group, comparison of numerical variables was done using Wilcoxon signed rank test. Freidman's test with Wilcoxon signed rank test for paired (matched) samples. For comparing categorical data, Chi-square (c2) test was performed. All statistical calculations were done using computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows.

RESULTS

The statistical methods revealed that there was a statistical significant difference in the ISQ values between the study's groups, all over the follow up period (*P* value= 0.004) (Table 1).

Table (1): *The mean ISQ values at different time points in group A and B*

Time point	Mean ISQ value		Significance
	Group A (medium stability)^{o}	Group B (high stability)^{o}	*P* Value
Immediate	64.33 ± 1.03	73.50 ± 1.04	0.004 *
2 month	61.33 ± 1.21	72.50 ± 1.37	0.004 *
4 month	65.00 ± 1.41	76.67 ± 0.817	0.004 *

*^{o}High stability means ISQ values >70 while medium stability means ISQ values between (60-69). * P value is significant.*

Operating Time: The difference between the groups was statistically significant, where a longer time was spent in ISP by using PEDs**.**

Marginal bone loss: There was no statistically significant difference in the MBL between the study's groups over the follow up period.

Bone mineral density: The statistical methods revealed that there was a border line significant difference in the BMD at the base time after ISP and at 3 months postoperative. While, after 6 months there was not a statistical significant difference. This result indicated that the PEDs promoted better bone density and enhanced bone remodeling during the early phases of the osseointegration compared to the CDs.

DISCUSSION

Several authors have reported that the CDs rupture the vasculature at the drilling site that leading to necrosis of bone and failure of implants[3,7]. Therefore, the PEDs were introduced to overcome the disadvantages of the CDs. In this

study, the implants' stability was used to evaluate the osseointegration of the implants which were inserted by using either PEDs or CDs. The implants' stability (both mechanical and biological stability), was evaluated with the Osstell Mentor which is based on the magnetic RFA to determine the ISQ values [8, 9].

The study's results showed that the mechanical implant stability of the group B was higher than that of the group A with a statistical significant value. This could be due to lesser traumatic effect of the PEDs on bone tissues that preserving trabecular bone architectures and its mechanical properties. This is in accordance with the results of previous studies [10, 11]. At the postoperative second month, there was a decrease in the mean of the ISQ values in both groups. This decrease represented the normal change that occurred during the early healing period at the bone-implant interface [12]. Another study also reported the same finding [13]. At the final ISQ values, the PEDs provided a significant higher implant stability than that which was provided with the CDs.

Regarding the drilling time of the ISP, the results showed that the PEDs needed longer time than that of the CDs. The difference was statistically significant. Another study also reported the same finding, where they recorded 6.00 minutes for the CDs and 7.15 minutes for the piezoelectric technique with a significant difference [14].

The results of the MBL, in the CDs group were higher than that in the PEDs group, but the difference was not statistically significant. There are different studies that support the study results [15, 16].

Regarding the BMD, the results showed that there was a significant higher BMD with the PEDs at the immediate and at 3 months than that was obtained with CDs. While, after 6 months, the difference was not statistically significant.

CONCLUSION

The osseointegration of implants which were placed by using the piezoelectric method was significantly greater than that placed with the conventional technique all over the time points, but the PEDs need significantly longer surgical time than the CDs.

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