Effect of a Multiporous Beta–Tricalcium Phosphate on Bone Density Around Dental Implants Inserted Into Fresh Extraction Sockets

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The aim of this study was to assess, via multi-slice helical computerized tomography (CT), the influence of the pure-phase multiporous beta–tricalcium phosphate (beta-TCP) on bone density around dental implants inserted into fresh extraction sockets. Twenty-eight patients (18 women and 10 men), indicated for extraction of their lower premolars and insertion of immediate dental implants, were included in this study. They were randomly divided into two equal groups (14 patients each). Group A received immediate dental implants without any filling material around the implants, while in group B, a pure-phase multiporous beta-TCP was gently packed into the bone gaps around the implants. Three and 6 months after loading the implants, a CT, sagittal and coronal, was made to measure the bone density around the implants. The results of the current study have shown that the mean values of the bone density measurements around the implants in group A were 1150 ± 205 (range, 645–1460) at 3 months and 1245 ± 165 (range, 884–1650) at 6 months after loading the implants. In group B, the mean values of the bone density measurements around the implants were 1280 ± 320 (range, 876–1790) and 1490 ± 358 (range, 1061–1965) at 3 and 6 months after loading the implants, respectively. The statistical analysis of the collected data showed a significant increase in the bone density measurements from 3 to 6 months only in group B (P < .05). Also, the difference between group A and B in the bone density measurements around the implants was statistically significant (P < .05) at only 6 months after loading. On the basis of the results presented in this study, it may be possible to mention that the pure-phase multiporous beta-TCP may enhance the bone density when inserted into the bone gaps around immediate dental implants.

Key Words: immediate implants, beta–tricalcium phosphate, bone density

INTRODUCTION

Despite the great advancement of modern dentistry, loss of natural teeth for one reason or another is still present. Bone resorption after tooth extraction decreases the height and width of the alveolar bone.1–3 The immediate placement of dental implants into fresh extraction sockets has several advantages, including preservation of the alveolar ridge at the extraction site, reducing the number of surgical interventions, and decreasing the cost for the patient. Thus, it improves the life quality of the patient as it allows a faster and better final rehabilitation.4–6

The discrepancy in size and form between the extraction socket and the implant usually leaves bone defects particularly around the coronal portion of the implant. These residual bone defects adjacent to the immediate dental implants may endanger their success. It has been reported that large bone gaps around immediate dental implants may interfere with the osseointegration process because of migration of the surrounding soft tissues into these gaps.7,8 Several authors9–15 have tried various techniques, such as the use of barrier membranes, autogenous bone, and bone substi-
tutes with or without platelet-rich plasma, to manage this problem.

As mentioned by Chow, the use of calcium phosphates as a stimulus for bone formation appeared in the literature as early as 1920. Tricalcium phosphate (TCP) has been used as a ceramic bone substitute material in the orthopedic field and in craniofacial surgery. It exists mainly in alpha and beta phases. Both forms are resorbed simultaneously with new bone formation when they are used to promote healing of osseous defects. However, the beta phase usually shows a slower rate of degradation than the alpha one. Beta–tricalcium phosphate (beta-TCP) is currently used by oral and maxillofacial surgeons to augment the deficient alveolar bone and to fill the osseous defects in the maxillofacial region.

Concerning the assessment of bone density, several methods are available, including densitometry, direct digital radiography, bone biopsy, and so forth. Multi-slice helical computerized tomography (CT) is considered one of the current modalities for measuring the bone density in Hounsfield units. It has been proposed that it may have low radiation exposure and reduces the need for bone biopsy. Also, Hounsfield unit measurement can be performed with a high degree of accuracy and reproducibility. The aim of this study was to assess, via a multi-slice helical CT, the influence of the pure-phase multiporous beta-TCP on bone density around dental implants inserted into fresh extraction sockets.

**MATERIALS AND METHODS**

This study was carried out on 28 patients (18 women and 10 men) who attended the outpatient clinic of Oral & Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University, for extraction of their mandibular premolars and insertion of immediate dental implants. Their ages ranged from 22 to 48 years, with an average age of 34 years. The causes of extraction were trauma, extensive dental caries, and failed endodontic treatment. A routine case history and clinical as well as radiographic examinations were made for every patient.

The exclusion criteria were poor oral hygiene, bruxism, deep bite, and receiving radiotherapy or chemotherapy. Prior to the trial, every patient was informed about the surgical procedures, the aim of the study, and the possible complications. A signed informed consent was obtained from all patients.

The patients were randomly divided into two equal groups (14 patients each). Randomization was performed using a computer-generated random-number list. Group A received immediate dental implants without any filling material around the implants, while in group B, a pure-phase multiporous beta-TCP was gently packed into the bone gaps around the dental implants. For every patient, a digital panoramic radiograph and digital cross-sectional tomography with corrected magnification 1:1 were made to determine the appropriate length and diameter of the implant.

**Surgical procedures**

All patients were operated on in an outpatient basis under local anesthesia using 2% mepivacaine hydrochloride and levonorchefrin (1:20 000) as a vasoconstriction agent (Mepecaine-L; Alexandria Co. for Pharmaceuticals, Alexandria, Egypt). Before surgery, the patient was asked to rinse with antiseptic mouth wash (Betadine; the Nile Co. for Pharmaceuticals and Chemical Industries, Cairo, Egypt). Using a blade no. 15, a gingival incision was made around the tooth to be extracted with slight mesial and distal extensions toward the buccal sulcus. After elevating a full-thickness mucoperiosteal flap, atraumatic extraction of the tooth was carefully carried out to preserve the alveolar bone. The extraction socket was gently curretted and irrigated with sterile normal saline to remove any debris or granulation tissue.

Using the supplied dental implant surgical kit (Oraltronics, Bremen, Germany), the implant site was prepared by a sequential drilling according to the manufacturer’s instructions. The drilling was performed with a reduced-speed contra-angle (2000 rpm) under copious irrigation with sterile normal saline. A screw-shaped titanium implant (PITT-EASY, BIO-oss System; Oraltronics) was inserted into the prepared site and extended beyond the tooth socket by 3 mm. Then, the covering screw was attached to the coronal end of the implant. The lengths and diameters of the implants ranged from 14 to 16 mm and from 3.75 to 4 mm, respectively. Every patient received only one implant.

In group A, no filling material was placed into the bone gaps around the implant, whereas in group B, pure-phase multiporous beta-TCP particles
with diameter 500–1000 μm (Cerasorb M, Curasan AG, Lindigstrasse, Kleinostheim, Germany) were mixed with a sterile normal saline and gently packed into the peri-implant bone gaps (Figure 3). In all cases, the width of bone defects at the coronal portion of the implants was larger than 2 mm. A horizontal periosteal incision was made at the base of the inner surface of the flap to facilitate its advancement. Finally, the mucoperiosteal flap was readapted and sutured by 3-0 black silk. Antibiotics (amoxycillin) and a nonsteroidal anti-inflammatory drug (ibuprofen) were prescribed for 1 week. All patients were instructed to apply intermittent extraoral cold fomentations at the operated side, for 24 hours, to minimize postoperative edema and pain. In addition, they were instructed to eat soft foods for 14 days and to perform usual oral hygiene measurements. The sutures were removed 10 days after surgery.

Three months after surgery, all patients had the second stage of implantation, which included removal of the covering screw, insertion of the gingival former for 2 weeks, and then making an indirect impression to construct the fixed prosthesis. The final crowns, made of porcelain fused to nickel-chrome alloy (Metaplus VK, AZ & Partner AG, Schotz, Switzerland), were cemented to the abutments, which were secured to the implants. The patients were recalled at 3 and 6 months after loading the implants for clinical assessment and measuring the bone density around the dental implants.

**Bone density measurement**

A CT, sagittal and coronal, was made for every patient via a multi-slice helical CT unit (Somatom Plus, Siemens Co, Munich, Germany) at 120 KV and 200 mA. The CT scan presented true sagittal and coronal views. The region of interest was 3 mm around the implant. The digital data from the CT scan were transformed to a computer for processing using vision software. The bone density of the mesial, distal, buccal, and lingual walls around each implant was measured at five points in each wall (Figure 4A and B). The mean value of the bone density measurement was calculated and recorded.
density measurements, at the 20 points of the four walls, represented the bone density around each implant. The bone density was measured in Hounsfield units.

Statistical analysis

The collected data were presented as the mean ± standard deviation (SD). The statistical analysis was performed using a paired t test. The differences were considered significant at \( P < .05 \).

Results

The patients of both groups tolerated the surgical procedures well and rapidly recovered after surgery. In general, the surgical wounds healed uneventfully without any serious complications. However, two women in group A had a mild soft-tissue infection at the surgical sites. This superficial infection has been successfully controlled by a continuous irrigation with chlorhexidine mouthwash and oral antibiotic therapy. All patients attended the follow-up periods regularly. The clinical assessment revealed successful implants in both groups as no evidence of implant failure was detected throughout the follow-up period.

In general, the mean values of the bone density measurements at 3 and 6 months after loading the implants were higher in group B than in group A. In group A, the mean values of the bone density measurements around the implants were 1150 ± 205 (range, 645–1460) at 3 months and 1245 ± 165 (range, 884–1650) at 6 months after loading the implants. In group B, the mean values of the bone density measurements around the implants were 1280 ± 320 (range, 876–1790) and 1490 ± 358 (range, 1061–1965) at 3 and 6 months after loading the implants, respectively (Figure 5).

The statistical analysis of the collected data showed an increase in the bone density measurements from 3 to 6 months in both group A and B. However, the increase in the bone density was statistically significant only in group B (\( P < .05 \)). After loading the implants for 6 months, the difference between group A and B in the bone density measurements around the implants was statistically significant (\( P < .05 \)). However, at 3 months after loading the implants, the difference in bone density between the two groups was statistically insignificant (\( P > .05 \)).

Discussion

A great alveolar bone resorption usually occurs during the first 3 months after teeth extraction. The immediate insertion of dental implants into fresh extraction sockets plays an essential role for preserving the height and width of the alveolar bone. Also, it reduces the time elapsed from the teeth extraction to complete rehabilitation.\(^3,4\) However, immediate implantation into fresh extraction sockets is often associated with residual bone defects between the implant and the socket walls. The oral soft tissues, connective tissue and epithelium, may migrate into such gaps, preventing the osseointegration process, which is essential for the success of the immediate implants.\(^10\) The present study aimed to evaluate, using a CT, the effect of filling the peri-implant defects with a pure-phase multiporous beta-TCP on bone density around immediate dental implants.

The synthetic bone substitutes are currently used in orthopedics, traumatology, and dental applications. The beta-TCP is commonly used for these purposes. It is available in various forms, which differ mainly in the size and shape of the particles, structural stability, diameter and number of the porosity, and solubility. The pure-phase multiporous beta-TCP is made of irregular granules having a high number of pores with different diameters. As mentioned by Pati and Hoch,\(^22\) it has a resorption rate simultaneous with new bone formation.

The results of the present study have shown a proper healing of the surgical wounds in both
groups. This indicates that the pure-phase multiporous beta-TCP is a biocompatible material. This is consistent with that mentioned by Szucs et al. Also, in the current study, the results demonstrated that the bone density measurements around the dental implants increased in both group A and B from 3 to 6 months after loading. However, the increase in bone density was statistically significant only in group B, which received a bone substitute filling around the dental implants. Furthermore, at 6 months after loading the implants, the difference in bone density measurements around the implants between group A and B (higher) was statistically significant. This indicates that insertion of the pure-phase multiporous beta-TCP into the bone gaps around the immediate dental implants may enhance the new bone formation. These findings are in agreement with the results of Gera et al and others. However, they contradict the findings of Handschel et al. They have mentioned that TCP is hardly absorbed and is a nonosteoconductive material as their results have shown no evidence for bone regeneration or TCP degradation after its insertion into calvarial bone defects of adult Wistar rats. This contradiction may be because of using a different methodology.

On the basis of the results presented in this study, it may be possible to mention that the pure-phase multiporous beta-TCP may enhance the bone density when inserted into the bone gaps around immediate dental implants. However, we believe that further clinical and experimental studies with longer follow-up periods and larger samples are mandatory to support the results of the present study.

**ABBREVIATIONS**

CT: computed tomography  
TCP: tricalcium phosphate

**REFERENCES**


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