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Is Beta-Tricalcium Phosphate Combined With Type I Collagen Effective for Human Socket Preservation Prior to Implant Placement? - A Case Report

SUMMARY

The authors report the use of synthetic beta-tricalcium phosphate with type I collagen immediately after tooth extraction for simple socket preservation indicated in the pre-implant management of alveolar bone. The bone material was used without a barrier membrane and forming a mucoperiosteal flap. Clinical examination revealed solid new bone formation with no changes in vertical and horizontal dimensions 9 months after the socket preservation. Immunohistochemical analysis demonstrated presence of active osteonectine-positive cells. The new bone formed after the use of beta-tricalcium phosphate and type I collagen in the socket preservation method can allow dental implant placement and implant loading.

Keywords: Beta-tricalcium Phosphate; Type I Collagen; Alveolar Socket, preservation; Immunohistochemistry; Dental Implants

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CASE REPORT (CR)
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Introduction

Dental implants have become generally accepted treatment in the management of partially or totally edentulous patients. For successful clinical outcomes, adequate quality and quantity of bone are necessary to ensure long-term implant stability. However, significant reduction in bone volume in both horizontal and vertical directions after tooth extraction may affect the successful placement and osseointegration of dental implants[1,2].

The preservation of the socket dimensions immediately after tooth extraction is a method which has been attempted by different bone substitutes to increase the quality of bone regeneration and to maintain the original dimensions of alveolar bone[3-5]. Beta-tricalcium phosphate (β-TCP) is synthetic material with osteoconductive properties. Bone regeneration with successful clinical and histological results has been reported in cases where β-TCP was used to fill bone defects after cyst removal, sinus-lift surgery and isolated alveolar ridge augmentation without the use of a barrier membrane[6-8].

The **aim** of this report was to present clinical, radiographic and immunihistochemical evidence of the extraction socket preservation in a patient treated with β-TCP associated with type I collagen prior to dental implant placement.

Case Report

A 30-year-old healthy female was presented for implant placement consultation after the extraction of second upper left premolar for single-crown rehabilitation. The tooth was indicated to be removed since the transversal fracture of the root was found with the failure of endodontic treatment (Fig. 1a).

The tooth extraction was done under the maxillary infiltration anaesthesia. After extraction of the tooth and wound debridement, the extraction socket was filled with beta-tricalcium phosphate and type I collagen (β-TCP/ Clg - RTR Cone®, Septodont, Saint-Maur-des-Fosses, France) from the apical part of the socket to the crestal

bone level. The material and the socket opening were left to heal spontaneously since no barrier membrane was used for the guided tissue regeneration, or mucoperiosteal flap performed (Fig. 1b). A course of antibiotics and pain medication with appropriate instructions were administered to the patient for 5 days. The follow-up examinations were done at 3, 5 and 7 days, and, associated with radiographs, at 4 and 9 months after the placement of the material.

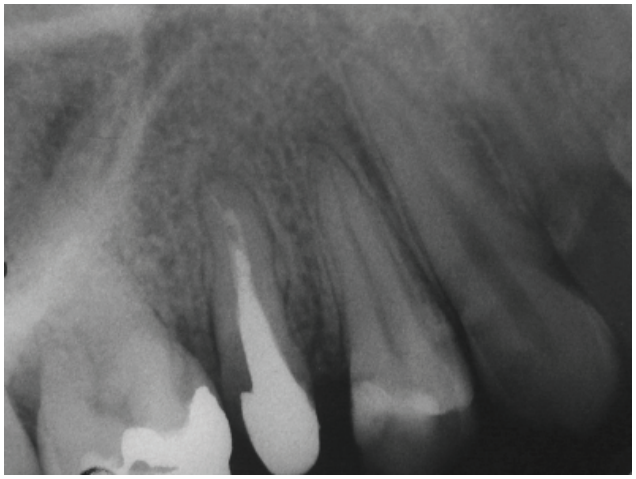

Figure 1a. Radiograph confirms indication for tooth extraction

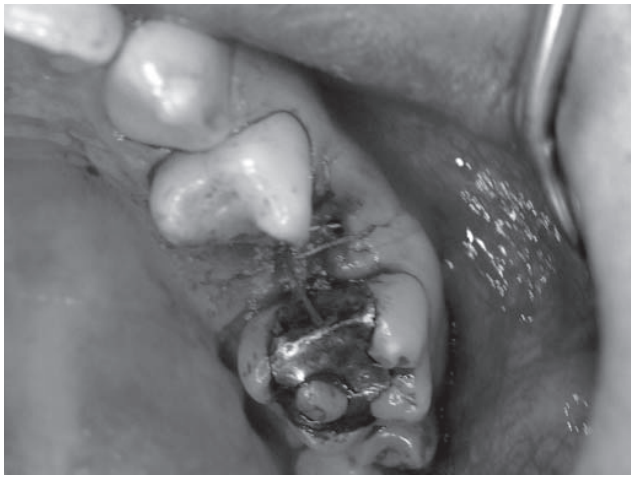

Figure 1b. β-TCP/Clg placed into the alveolar socket and secured by sutures. No barrier membrane and mucoperiosteal flap used

Nine months after the socket preservation, the re-entry procedure of the grafted area was done for bone biopsy and implant placement (Replace®, NobelBiocare, Sweden). The bone was evaluated by immunohistochemical analysis using 4 μm thick sections, mounted on poly-L-lysine coated glass slides. Antigen retrieval was achieved by heating slides with citrate buffered solution into a micro-wave oven at 2 circles of 5 min each. Afterwards, sections were incubated in 4 C° in a humified chamber with the primary antibody against osteonectin (clone NCL-O-NECTIN 15G12, Novocastra Co.UK) at a dilution 1:20 overnight. A 2-step technique was used for the secondary antibody (Envision, Dako Ca, USA). Diaminobenzidine was preferred as chromogen and slides were lightly counterstained with haematoxylin and mounted.

Clinically, the grafted area healed uneventfully with completed gingiva closure of the socket opening in 2 weeks (Fig. 2, a and b). There were no signs of infection, exudation or material loosing during the observation period of 9 months. The residual alveolar bone 9 months after the socket preservation was adequate for the implant placement (length of 12 mm, and diameter of 4.3 mm), without significant resorption in both vertical and horizontal directions (Fig. 2, c-e). There were no clinical signs and symptoms of implant/crown failure 2 years after loading (Fig. 2f).

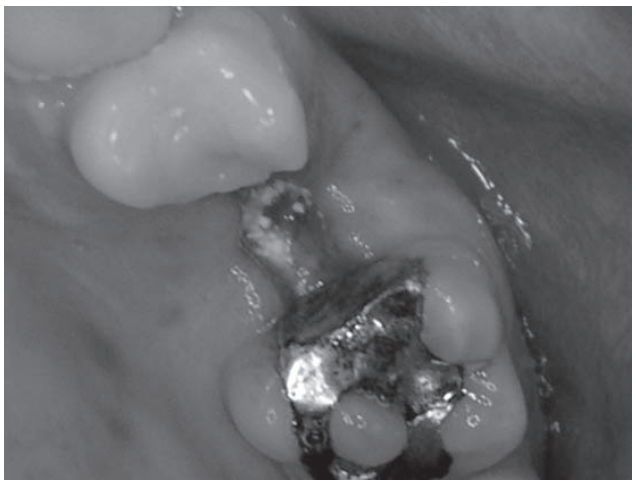

Figure 2a. 3 days after β-TCP/Clg placement and subsequent closure of the socket opening;

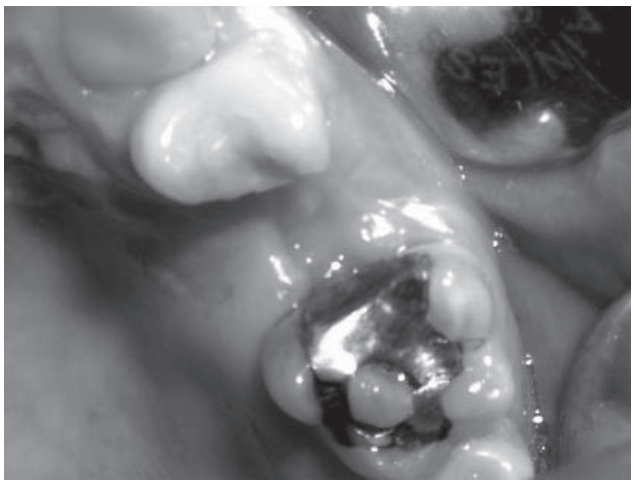

Figure 2b. A complete closure of socket opening after 2 weeks;

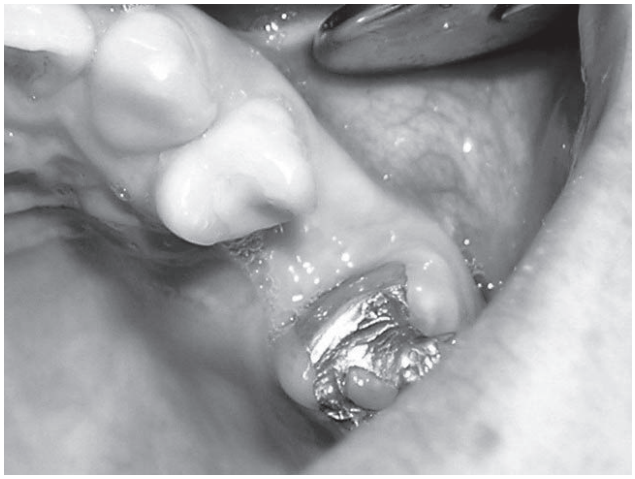

Figure 2c. Healed gingival wound 9 months after alveolar socket preservation;

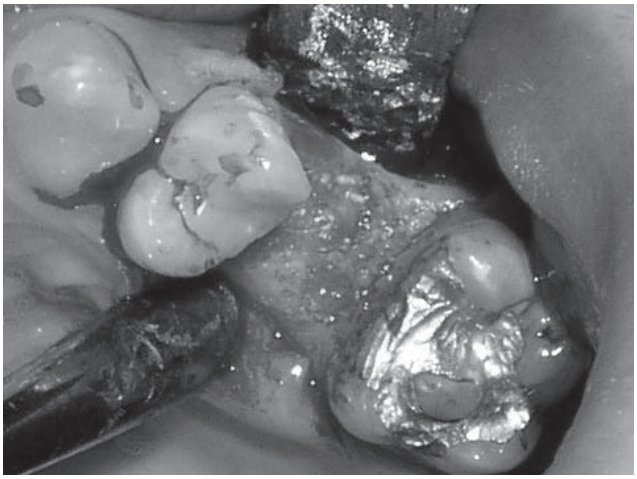

Figure 2d. Re-entry of the alveolar bone for implant insertion 9 months after alveolar socket preservation. New bone formation is compact and solid without horizontal resorption of alveolar ridge;

Figure 2e. No reduction in vertical dimension of the alveolar ridge 9 months after the socket preservation

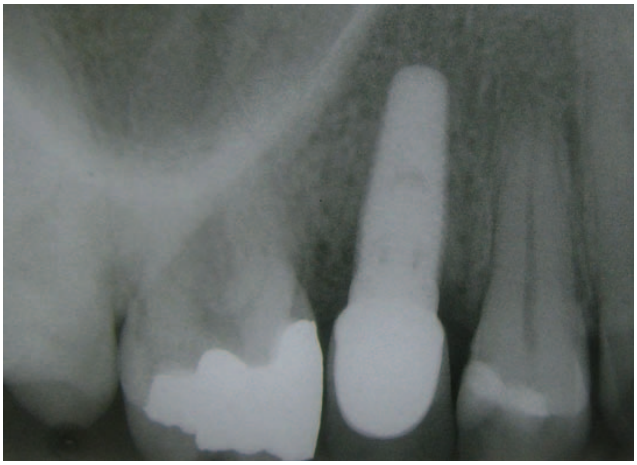

Figure 2f. Radiograph of the implant and crown 2 years after the prosthetic rehabilitation

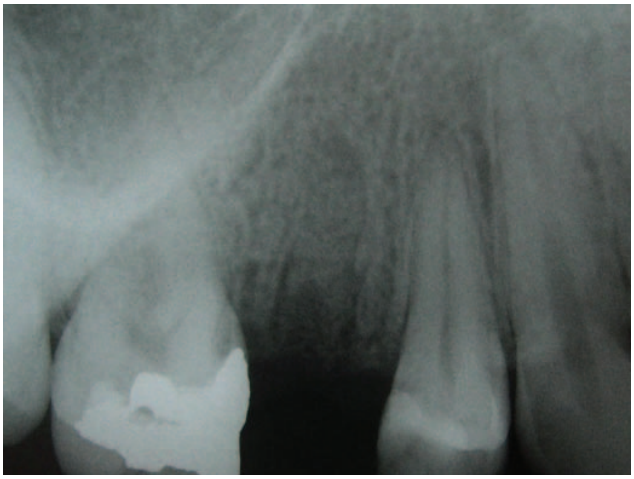

Figure 3a. Periapical radiograph taken 7 days after the placement of β-TCP/Clg;

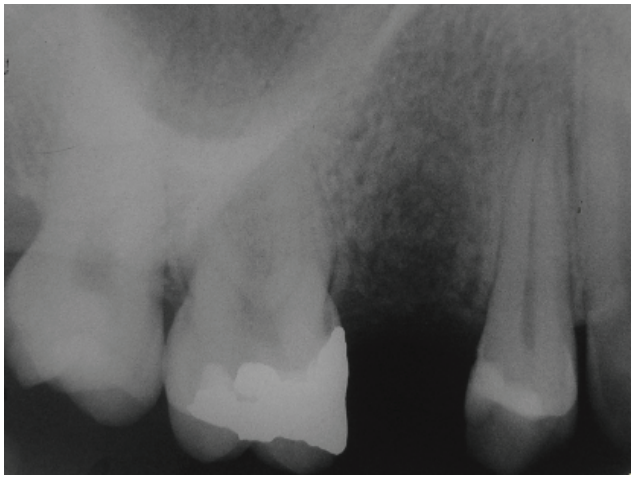

Figure 3b. Radiograph taken after 6 months showing peripheral bone formation and central radiolucency;

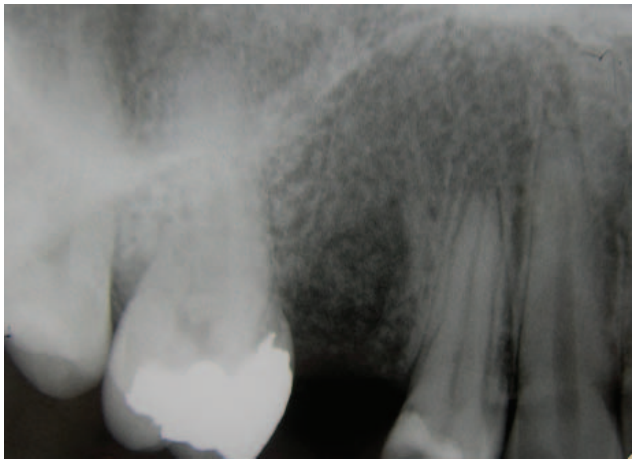

Figure 3c. Radiograph taken after 9 months showing complete bone fill of the socket with slight decrease in bone density at the central position

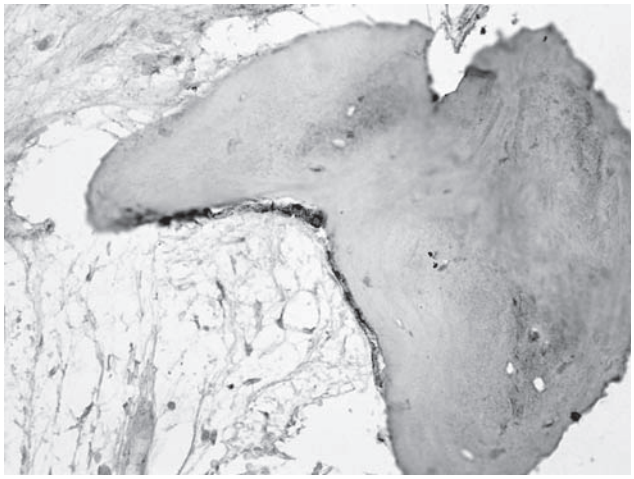

Figure 4a. Osteonectine-stained β-TCP/Clg-treated socket 9 months after alveolar socket preservation. Cells stained for osteonectine were seen close to the mineralized new bone formation (an original magnification x 100);

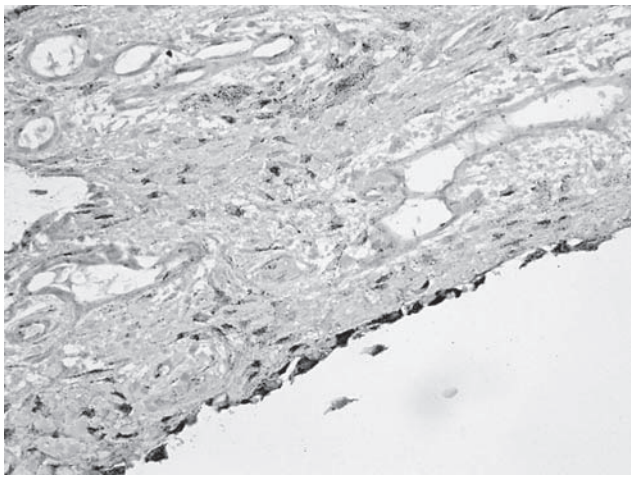

Figure 4b. Osteonectine-positive cells localized in fibrous tissue and bone marrow (an original magnification x 100)

Radiographically, a radio-dense structure of bone appeared to be seen peripherally, with central location of radio-lucency after 9 months of healing period (Fig. 3, a-c). There was no appearance of the residual graft material at the time of implant placement. Two years of loading did not show a crestal bone resorption around the implant body (Fig. 2f).

Immunohistochemically, the osteonectine expression was mainly detected in differentiating osteoblasts or osteoblast-like cells lying over the newly formed bone (Fig. 4a). Some osteonectine positive cells were also found in bone marrow (Fig. 4b). The intensity of positive immunostaining was graded from mild to strong.

Discussion

This case demonstrates that β-TCP/Clg provides an effective scaffold which can allow in-growth of active cellular and vascular components inside the material. This characteristic of osseoconductive material will promote a formation of new mineralized bone and bone marrow in a human extraction socket. The presence of newly formed bone, lined with osteonectine-positive cells, demonstrated that active bone formation was still in process. Furthermore, osteonectine-staining cells were taking places not only around new bone but also inside of fibrous tissue, which finally resulted in the appearance of new centres of ossification. In addition, type I collagen combined with β-TCP induces osteogenesis by supporting osteoblastic differentiation and proliferation resulted in acceleration of the healing process in bone defects[9,10].

There was no residual graft material detected after 9 months because the relatively fast biodegradation of β-TCP occurs by both chemical dissolution and osteoclastic-cell activity[11] what could be a reason why the slight central radiolucency were observed on radiographs.

The most important factor seams to be that a barrier membrane and a mucoperiosteal flap have not played any crucial rule in case with all 4-wall socket preservation what was also documented by Herberer et al[12] using BioOss + Collagen in the same model of human socket preservation. The alveolar crestal bone level did not change over time of bone healing, as well as during the loading time of 2 years. On the other hand, resorption of the alveolar bone during the physiological healing of extraction sockets is usually expected with the significant changes in the first 3 months after extraction[1]. There are several possible mechanisms to explain the blockade of fibrous tissue in-growth into the porous material structure of the β-TCP granules. Metabolites and a local decrease in pH during the material dissolution can inhibit the fibroblastic proliferation[13,14], while afterward that process will be intensive by a strong connection of material and bone through the ions reaction[9,15].

Regarding the results of this clinical case, it can be concluded that the combination of β-TCP/Clg can prevent the reduction of original dimension of the alveolar bone when used for the preservation of 4-wall extraction socket without the barrier membrane and surgical flap used. The active bone formation ensured the quality of regeneration important for successful implant osseointegration.

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References

1. *Chen ST, Wilson TG, Hämmerle CH*. Immediate or early placement of implants following tooth extraction: Review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants*, 2004; 19:12-25.
2. *Schropp L, Wenzel A, Kostopoulos L, Karring T*. Bone healing and soft tissue contour changes following single-tooth extraction: A clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent*, 2003; 23:313-323.
3. *Carmagnola D, Adriaens P, Berglundh T*. Healing of human extraction socket filled with Bio-Oss®. *Clin oral Impl Res*, 2003; 14:137-143.
4. *Brkovic BMB, Prasad HS, Konandreas G, Radulovic M, Antunovic D, Sándor GKB, Rohrer M*. Simple preservation of a maxillary extraction socket using beta-tricalcium phosphate with type I collagen: preliminary clinical and histomorphometric observation. *JCDA*, 2008; 74:513-518.
5. *Rothamel D, Schwarz F, Herten M, Engelhardt E, Donath K, Kuehn P, Becker J*. Dimensional ridge alterations following socket preservation using a nanocrystalline hydroxyapatite paste. A histomorphometrical study in dogs. *Int J Oral Maxillofac Surg*, 2008; 37:741-747.
6. *Zerbo IR, Bronckers ALJJ, de Lange GL, van Beek GJ, Burger EH*. Histology of human alveolar bone regeneration with a porous tricalcium phosphate. A report of two cases. *Clin Oral Impl Res*, 2001; 12:379-384.
7. *Zijderveld SA, Zerbo IR, van den Bergh JPA, Schulten EAJM, ten Bruggenkate CM*. Maxillary sinus floor augmentation using a β-tricalcium phosphate (Cerasorb) alone compared to autogenous bone graft. *Int J Oral Maxillofac Implants*, 2005; 20:432-440.
8. *Horch HH, Sader R, Pautke C, Neff A, Deppe H, Kolk A*. Synthetic, pure-phase beta-tricalcium phosphate ceramic granules (Cerasorb®) for bone regeneration in the reconstructive surgery of the jaws. *Int J Oral Maxillofac Surg*, 2006; 35:708-713.
9. *Zou C, Weng W, Deng X, Cheng K, Liu X, Du P, Shen G, Han G*. Preparation and characterization of porous beta-tricalcium phosphate/collagen composites with an integrated structure. *Biomaterials*, 2005; 26:5276-5284.
10. *Ignatius A, Blessing H, Liedert A, Schmidt C, Neidlinger-Wilke C, Kaspar D, et al*. Tissue engineering of bone: effects of mechanical strain on osteoblastic cells in type I collagen matrices. *Biomaterials*, 2005; 26(3):311-318.
11. *Lu J, Descamps M, Dejou J, Koubi G, Hardouin P, Lemaitre J, Proust JP*. The biodegradation mechanism of calcium phosphate biomaterials in bone. *J Biomed Mater Res*, 2002; 63:408-412.
12. *Herberer S, Al-Chawaf B, Hildebrand D, Nelson JJ, Nelson K*. Histomorphometric analysis of extraction sockets augmented with Bio-Oss Collagen after a 6-week healing period: a prospective study. *Clin Oral Impl Res*, 2008; 19:1219-1225.
13. *Pioletti DP, Takei H, Lin T, Van Landuyt P, Ma QJ, Kwon SY, Sung KL*. The effects of calcium phosphate cement particles on osteoblast function. *Biomaterials*, 2000; 21:1103-1114.
14. *Zerbo IR, Bronckers AL, de Lange G, Burger EH*. Localization of osteogenic cells and osteoplastic cells in porous beta-tricalcium phosphate particles used for human maxillary sinus floor elevation. *Biomaterials*, 2005; 26:1445-1451.
15. *Fujita R, Yokoyama A, Nodasaka Y, Kohgo T, Kawasaki T*. Ultrastructure of ceramic-bone interface using hydroxyapatite and β-tricalcium phosphate ceramics and replacement mechanism of β-tricalcium phosphate in bone. *Tissue and Cell*, 2003; 35:427-440.

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