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Effects of Choukroun's platelet-rich fibrin on bone regeneration in combination with deproteinized bovine bone mineral in maxillary sinus augmentation: A histological and histomorphometric study

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ABSTRACT

Purpose: The potential effect of Choukroun's platelet-rich fibrin (PRF) in combination with allograft on promoting bone regeneration has been discussed in previous publications. This study aims to evaluate an influence of PRF on bone regeneration in sinus augmentation in combination with a xenograft, deproteinised bovine bone.

Materials and methods: Eleven sinuses from 10 patients with posterior maxillary bone atrophy were selected for the study. As a test group, six sinus floor elevations were grafted with a Bio-Oss and PRF mixture, and as control group, five sinuses were treated with Bio-Oss alone. Clinical and radiographic examinations were performed pre- and postoperatively. After 6 months of sinus augmentation, bone biopsies were obtained from the grafted posterior maxilla, and un-decalcified ground sections were prepared. Bone characteristics were evaluated using histological observation and histomorphometric analyses.

Results: No adverse effect was observed in any case within the follow-up period of 6 months after sinus augmentation. Histological observation showed similar morphological characteristics for both the PRF and control groups. The percentage of new bone formation in the PRF group was about 1.4 times of that in control (18.35% ± 5.62% vs. 12.95% ± 5.33%), while the percentage of residual bone substitute in the control group was about 1.5 times higher as that in the PRF group (28.54% ± 12.01% vs. 19.16% ± 6.89%). The percentage of contact length between newly formed bone and bone substitute in the PRF group was 21.45% ± 14.57% vs. 18.57% ± 5.39% in the control. No significant statistical differences between the two groups were found in these observed parameters.

Conclusions: Our preliminary result demonstrated neither an advantage nor disadvantage of the application of PRF in combination with deproteinised bovine bone mineral in sinus augmentation after a healing period of 6 months.

1. Introduction

Platelet-rich plasma (PRP) has been increasingly investigated as a potential bioactive substance for improving bone regeneration, not only because it is an easily available autologous material, but also because it contains a high concentration of bioactive proteins (Marx et al., 1998; Zimmermann et al., 2001; Weibrich et al., 2002), which are able to stimulate cell proliferation, angiogenesis, matrix remodelling, and intrinsic bone regeneration in alveolar bone defects (Nevins et al., 2005; Ridgway et al., 2008; Simion et al., 2008). Combinations of growth factors, which are present in PRR, seem to have a synergistic effect on healing processes and tissue regeneration (Lynch et al., 1989; Greenhalgh et al., 1993).

PRP has been shown to promote cell proliferation and expression of osteogenic markers in human osteoblasts in vitro (Kanno et al., 2005; Clausen et al., 2006; Uggeri et al., 2007). However, the effect of PRP on bone regeneration in in vivo studies is contradictory. New bone formation was detected in a PRP grafted canine model in the first 2 months (Gerard et al., 2006; Gerard et al., 2007). In contrast, PRP gel does not enhance the bone healing process in mandibular defects in rabbits (Kazakos et al., 2011). The results of human studies are also inconsistent (Marx et al., 1998; Wiltfang et al., 2003; Raghoebar et al., 2005, Marukawa et al., 2010). Dispute has been focused on therapeutic platelet level (Marx, 2004), intrinsic

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osteoinductive property (Schilephake, 2002), and mostly short-term effects, because of the quickly fading level of bioactive proteins (Schmitz and Hollinger, 2001; Marx, 2004). Because the early effect of PRP on bone regeneration is generally supported (Schlegel et al., 2004; Butterfield et al., 2005; Kasten et al., 2008), new approaches have focused on prolonging the effect of PRP by using different activators (Anitua, 1999; Lacoste et al., 2003; Tsay et al., 2005) and release carriers (Hokugo et al., 2007).

Recently, an autologous platelet- and leucocyte-enriched fibrin matrix called Choukroun's platelet-rich fibrin (PRF) was introduced as a second-generation platelet concentrate (Dohan et al., 2006a). Centrifugation of freshly collected blood without adding any anti-coagulant or thrombin results in the natural formation of a leuko-cyte- and platelet-rich fibrin clot with bioactive proteins trapped inside, which represents a system for slow release of growth factors. In addition, fibrin formation supports cell migration (Dohan

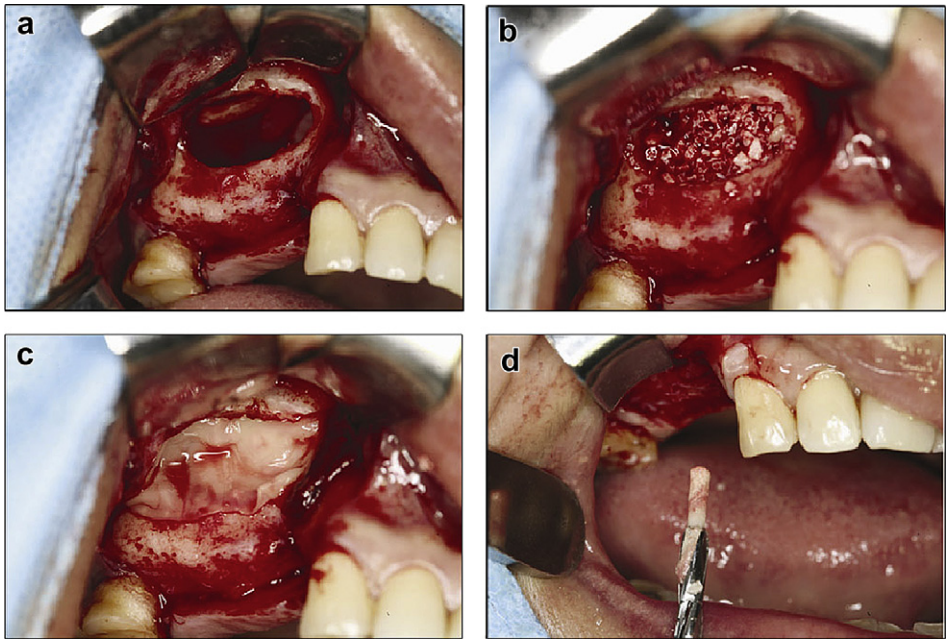

Fig. 1. Surgical procedures of sinus augmentation and removal of biopsy. (a) Osteotomy of lateral wall of sinus and elevated Schneiderian membrane. (b) Mixture of Bio-Oss and PRF was packed into the augmentation area. (c) The osteotomy window was covered with PRF membrane. (d) Biopsy was taken after 6 months.

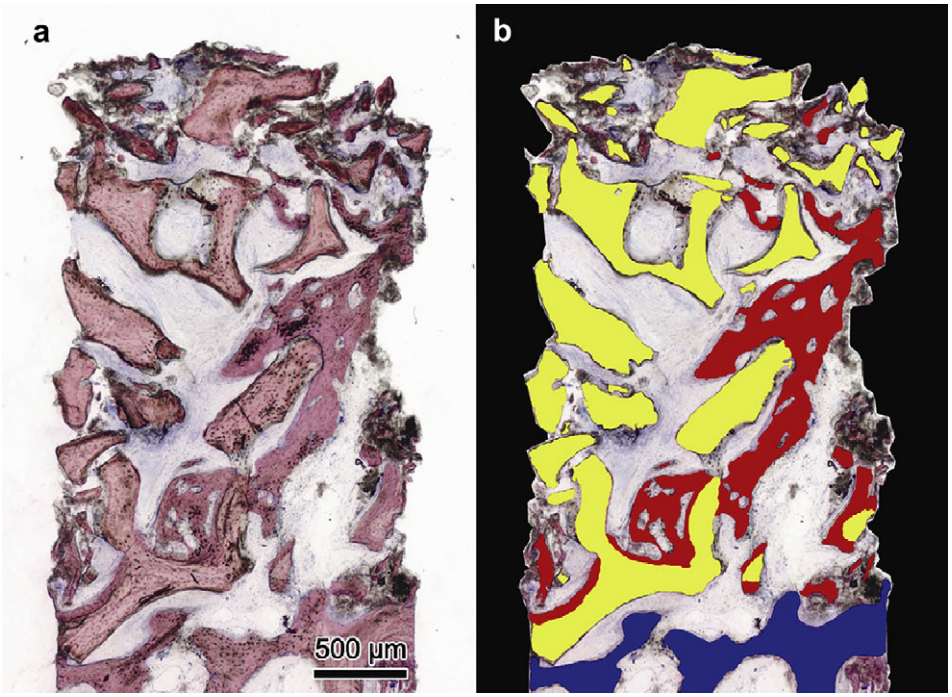

Fig. 2. Histology and histomorphometric evaluation of the biopsy section. (a) Un-decalcified ground section stained with Levai-Laczko stain. (b) Interactive colouring of different structures: local host bone (blue), Bio-Oss (yellow) and newly formed bone (red).