Comparison of two different ß-TCP composites for reconstruction of ovine mandibular continuity defects.

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INTRODUCTION: The reconstruction of large mandibular bone defects after traumatic bone loss or tumor resection is challenging surgeons around the world. Among the various investigated materials, ceramic scaffolds proved to be biocompatible and osteoconductive[1-3]. The aim of the study was to compare osseointegration and degradation of a blood-loaded ß-TCP composite (ß-TCP_B) with a similar composite that had been additionally loaded with autologous bone marrow and cancellous bone (ß-$TCP_{B/BM/CB}$) after reconstruction of critical size mandibular defects.

METHODS: Twelve German Black-Headed Sheep with an average weight of 72.5 +/- 10 kg underwent segmental resection of the right hemi-mandible. Animals assigned to group A (n=6) were reconstructed using blood-loaded ß-TCP_B while sheep assigned to group B received ß-$TCP_{B/BM/CB}$ grafts with a central through-bore-hole that was filled with bone marrow and milled autologous cancellous bone, both obtained from core biopsies taken from the iliac crest during the same surgery session. After a maintenance time of twelve weeks all sheep were sacrificed. Tissue quality was histologically assessed and bone-, scaffold-, cartilage- and fibrous-tissue area were estimated using semiautomated histomorphometrical software. The impact of the different graft types (TCP_B vs. $TCP_{B/BM/CB}$) and slide position (surface, intermediate, central) was examined using two-way analysis of variance with post hoc t-test for five pair wise comparisons between corresponding slides.

RESULTS: All animals underwent clinical uneventful healing. Two sheep presented inflammation of the graft side associated with graft dislocation at sacrifice and were excluded from further evaluation. Fracture of the reconstruction plates occurred in two animals of each group leaving three sheep per group that underwent bone healing under stable conditions. Statistical analysis revealed no significant difference between specimens retrieved from stable and unstable defects, thus affected animals were not separated and five specimens per group were included in further evaluation. New deposited bone within group A was immature and none of the specimens showed defect union. The defect center was still occupied by a ceramic core. Direct bone–ß-TCP contact was rare due to an intervening soft tissue layer. Animals assigned to group B achieved defect union and a high grade of bone maturation. Residual ceramic remnants were rare, disconnected and integrated within newly formed bone (Fig. 1).

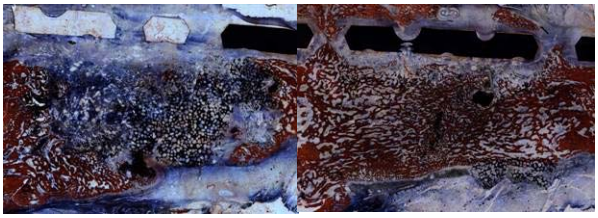

Fig. 1: Histological overview sections of defects grafted with ß-TCP_B (left) and ß-$TCP_{B/BM/CB}$ (right) Alizarin-red Methylene-blue stain

Composites in group B exhibited significant ($p<0.01$) higher amounts of bone formation and ß-TCP degradation than composites used in group A. Cartilage- and soft tissue area did not significantly differ between the two groups.

DISCUSSION & CONCLUSIONS: The described method offers the advantage of manufacturing an efficient bone graft substitute table-side during surgery using the patient's own cells, circumventing the need of cell culture, expansion, and preservation. The osteoregenerative capabilities of the $TCP_{B/BM/CB}$ composite indicate a promising potential for mandibular reconstruction.

REFERENCES: [1] Blokhuis TJ, Termaat MF, den Boer FC, Patka P, Bakker FC, Haarman HJ. Properties of calcium phosphate ceramics in relation to their in vivo behavior. J Trauma 2000;48(1):179-86. [2] Bauer TW, Muschler GF. Bone graft materials. An overview of the basic science. Clin Orthop Relat Res 2000: 10-27. [3] Bloemers FW, Patka, P, Bakker, FC, Haarman, HJTM. The use of calcium phosphates as a bone substitute material in trauma surgery. Osteo Trauma Care 2002: 10:33-37