Laboratory tests

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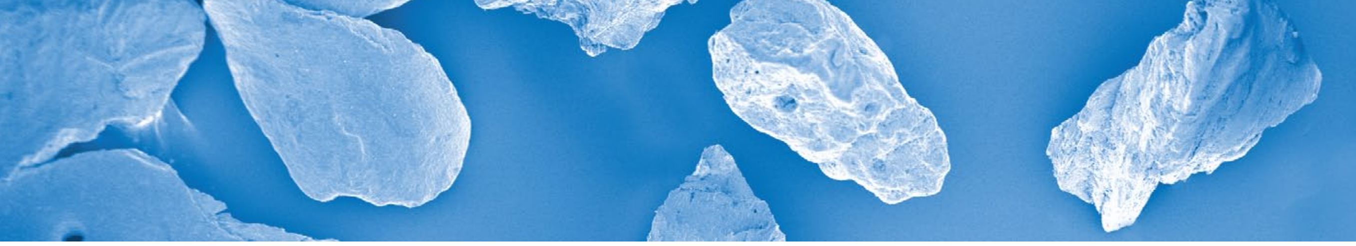
REGENERATION SCIENCE

INSPIRED BY NATURE



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Biofunctionalized scaffold in bone tissue repair

LABORATORY TESTS

132

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ABSTRACT

The aim of bone tissue engineering is to provide the right microenvironments to promote cell differentiation together with optimal scaffold development. In order to favour bone regeneration, the scaffolds need to be biocompatible, to lead the progenitor cells to commit to an osteogenic lineage and to avoid the possible host tissue inflammation or reaction. Moreover, they should provide an optimal microenvironment to support bone growth and development, the vascular network formation and cell recruitment. Different materials are used for the creation of the scaffolds. They can be tissue-derived materials, components of extracellular matrix (ECM), hydrogels or synthetic polymers. In this study, the Authors investigated the effect of human periodontal ligament stem cells (hPDLSCs) and their conditioned medium (CM) on bone regeneration using a commercially available collagen membrane scaffold OsteoBiol® *Evolution* (EVO) (Tecnoss®, Giaveno, Italy) with a high consistency dense collagen fiber derived from equine mesenchymal tissue. Collagen fibers constitute one of the main components of bone matrix and collagen-based scaffolds have been used and seem promising in bone tissue regeneration. Collagenous membranes were reported to induce osteogenesis *in situ* and collagenized porcine bone xenografts were demonstrated to be biocompatible, bioabsorbable, and osteoconductive in animal models. EVO alone or EVO + hPDLSCs with or without CM were implanted in Wistar male rats subjected to calvarial defects. *In vivo* bone regeneration in the grafted sites was evaluated after 6 weeks of implantation using fuchsine acid and methylene blue stained sections. The *in vivo* results revealed that EVO membrane enriched with hPDLSCs and CM showed a better osteogenic ability to repair the calvarial defect. These results were confirmed by acquired micro-computed tomography (CT) images and the increased osteopontin levels.

CONCLUSIONS

The results of this study revealed that EVO enriched with hPDLSCs and CM was able to almost completely repair the rat calvarial defect, showing a higher osteogenic ability compared with the other complexes. Moreover, the group EVO + CM + hPDLSCs showed the best regenerative capacity, indicating a synergistic effect of CM and hPDLSCs. In particular, CM played a key role and could have a very high potential for the induction of bone regeneration. These results suggest a promising potential application of CM from hPDLSCs and scaffolds for bone defect restoration and in particular for calvarial repair in case of trauma. Nevertheless, further investigations will be necessary to explain how the CM enhances the bone regeneration process.

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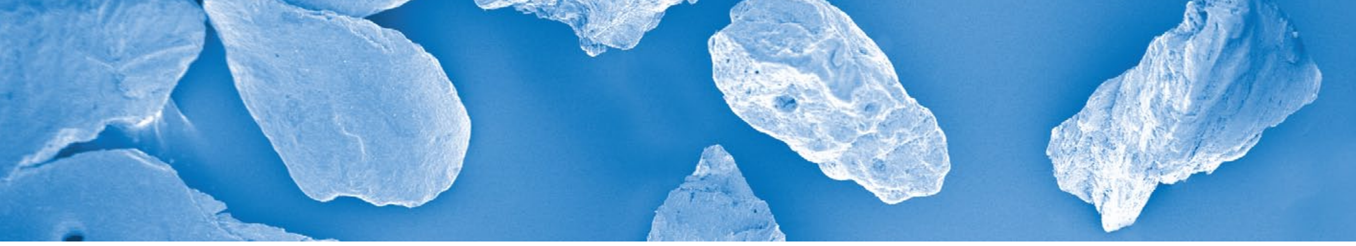

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Comparison of two xenograft materials used in sinus lift procedures: material characterization and in vivo behavior

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ABSTRACT

Loss of teeth in the posterior maxillary area can lead to severe maxillary sinus pneumatization, and in this anatomical situation, it can be very difficult to obtain a suitable primary stability of implants. Maxillary sinus augmentation is a predictable method to increase posterior maxillary bone height, allowing to place dental implants in case of a residual alveolar ridge with a reduced bone volume. In sinus lift procedures, several types of graft materials can be used. The aim of this study was to characterize the physico-chemical properties of two xenografts deproteinized at different temperatures and compare how the physico-chemical properties influence the material's performance in vivo by a histomorphometric study in retrieved bone biopsies following maxillary sinus augmentation in 10 clinical cases. The two materials were a bovine HAs scaffold (BBM) consisting of a highly porous network with an average pore size of 0.5 mm, and a porcine HAS scaffold (PBM) formed by small grains of 500 μm on average. The X-ray diffraction analysis revealed the typical structure of hydroxyapatite (HA) for both materials. Both xenografts were porous, with intraparticle pores. Strong differences were observed in terms of porosity, crystallinity, and calcium/phosphate ratio. Histomorphometric measurements on the bone biopsies showed statistically significant differences. Both xenografts showed to be characterized by an excellent biocompatibility, with similar characteristics to natural bone. At the 6 months follow-up, the success rate of the 10 partially edentulous patients was 100%. By the end of the healing period, the increased bone volumes were stable and it was evident a bone gain for both xenografts. At the moment of implant insertion, the augmented sites treated with PBM showed less dense new bone than BBM. The sintered HA xenografts exhibited greater osteoconductivity, but were not completely resorbable. The non-sintered HA xenografts induced about 25.92 ± 1.61% of new bone and a high level of degradation after six months of implantation. Differences in the physico-chemical characteristics (porosity, crystallinity and composition) found between the two HA xenografts determined a different behaviour for this material.

CONCLUSIONS

At the end of the study and after the evaluation of the results, the Authors concluded that *"the HAs assessed herein are shown to be biocompatible and osteoconductive when used for maxillary sinus elevation purposes. PBM displayed a high level of degradation over the study period"*. Anyway, more histological and histomorphometrical studies are needed to better understand the resorption times of these biomaterials.

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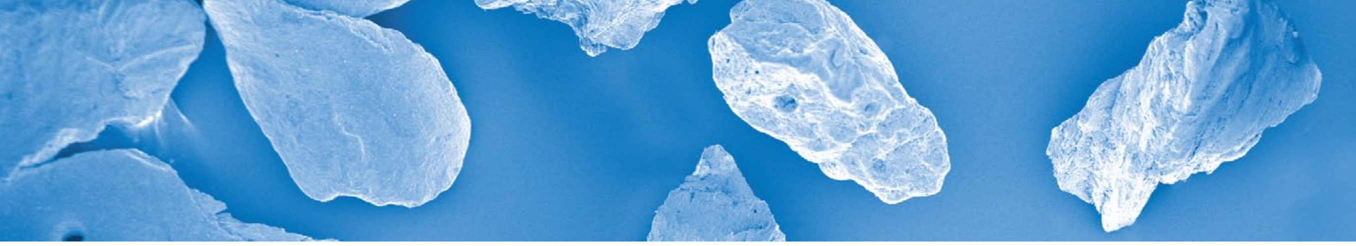

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A novel role in skeletal segment regeneration of extracellular vesicles released from periodontal-ligament stem cells

LABORATORY TESTS

164

ABSTRACT

The combination of biomaterials and stem cells represents a common strategy for bone-tissue-engineering applications and collagen membranes show ideal biological properties, supporting infiltration and proliferation of osteoblasts and promoting bone regeneration. In this interesting study, the Authors aimed to develop a new biocompatible osteogenic construct composed of a commercially available collagen membrane (OsteoBiol® *Evolution,* Tecnoss®, Giaveno, Italy), human periodontal-ligament stem cells (hPDLSCs) enriched with extracellular vesicles (EVs), or polyethylenimine (PEI)-engineered EVs (PEI-EVs). Evolution membrane was chosen because is a high-consistency dense collagen fiber derived from equine mesenchymal tissue featuring a maximum adaptability to hard and soft tissue, easy and secure suturability of nearby tissue, great stability, and sufficient protection of underlying grafts. Moreover, OsteoBiol® *Evolution* can be used as a drug carrier. OsteoBiol® *Evolution* enriched with hPDLSCs and EVs/PEI-EVs was investigated in rats subjected to calvarial defects and showed high biocompatibility and osteogenic properties in vitro and in vivo. In addition, quantitative reverse-transcription polymerase chain reaction demonstrated the up-regulation of osteogenic genes, such as TGFB1, MMP8, TUFT1, TFIP11, BMP2, and BMP4, in the presence of PEI-EVs.

CONCLUSIONS

Based on the encouraging findings of this study, the Authors conclude suggesting that *"Evo enriched with hPDLSCs and PEI-EVs is capable of inducing bone regeneration. In particular, PEI-EVs played a key role in the activation of the osteogenic regenerative process. Indeed, the presence of PEI-EVs improved the mineralization process and induced an extensive vascular network, suggesting an osseointegration process".*

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