In vivo experimental study of composite biomaterials based on collagen

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Introduction: Composite biomaterials based on collagen are used in oral-maxillo-facial surgery for restoring bone defects. The most widely used are collagen-based grafts of xenogeneic origin, which still have certain shortcomings in use, due to the possibility of transmitting zoonoses. Thus grafts based on human collagen, extracted from the umbilical-placental complex, would be a solution for maxillofacial bone reconstruction.



Figure 1. Collagen mineralization directly from hydroxyapatite precursor: a collagen, b- collagen with hydroxyapatite precursors, c-washing the composite, d- freeze-dried composite

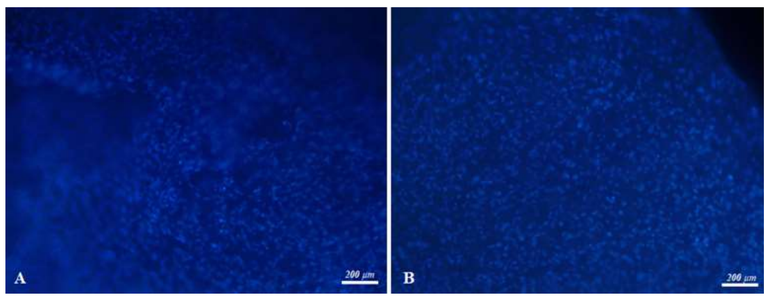


Figure 2. DAPI staining of the COLL/HA composite biomaterials, A) with bovine collagen, B) with human collagen from the umbilical-placental complex. Images taken with Optika microscope, IM-3F.

The purpose of this study was to evaluate biocompatibility of composite biomaterials based on collagen extracted from the umbilical-placental complex.

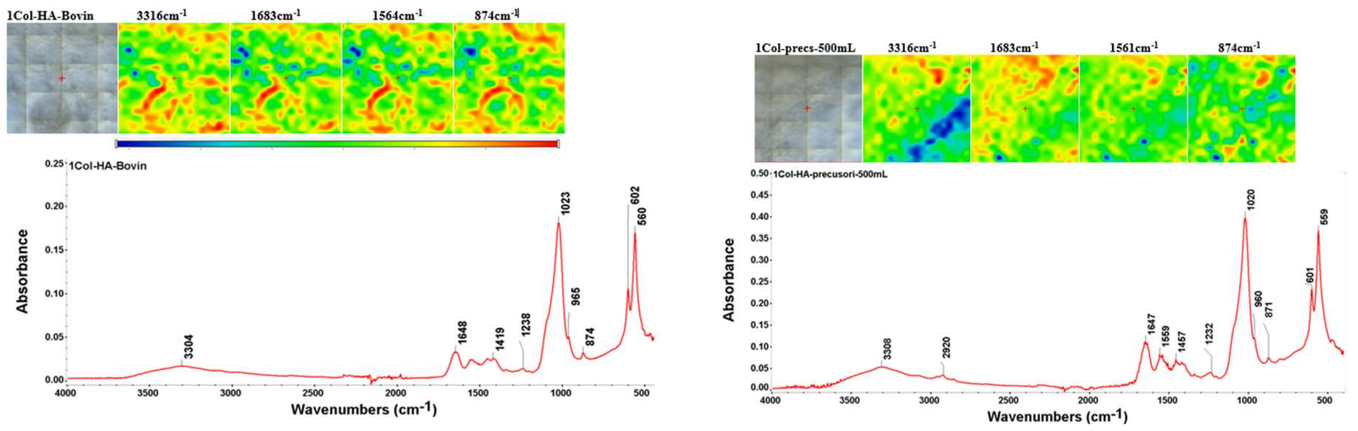


Figure 3. FTIR and FTIR map of composite biomaterials, a) bCOLL/HA , b)hCOLL/HA .

Results: Collagen/hydroxyapatite composite materials were obtained by mineralizing the collagen structure using soluble calcium salt precursors and soluble phosphates. Crosslinking of the biomaterial was performed with 1% glutaraldehyde. The composites obtained was washed for several days in distilled water and then lyophilized to obtain a potentially reliable graft for cellular population.

The control group consisted of a composite based on collagen extracted from the bovine Achilles tendon, whereas the experimental group consisted of a composite based on collagen isolated from the umbilical-placental complex. The obtained grafts were transplanted into Wistar rats in a 5mm calvarial defect. At one and three months, the rats were euthanized and blood samples were collected for determination of acid phosphatase analysis, antioxidant system indicators and oxidative stress markers.

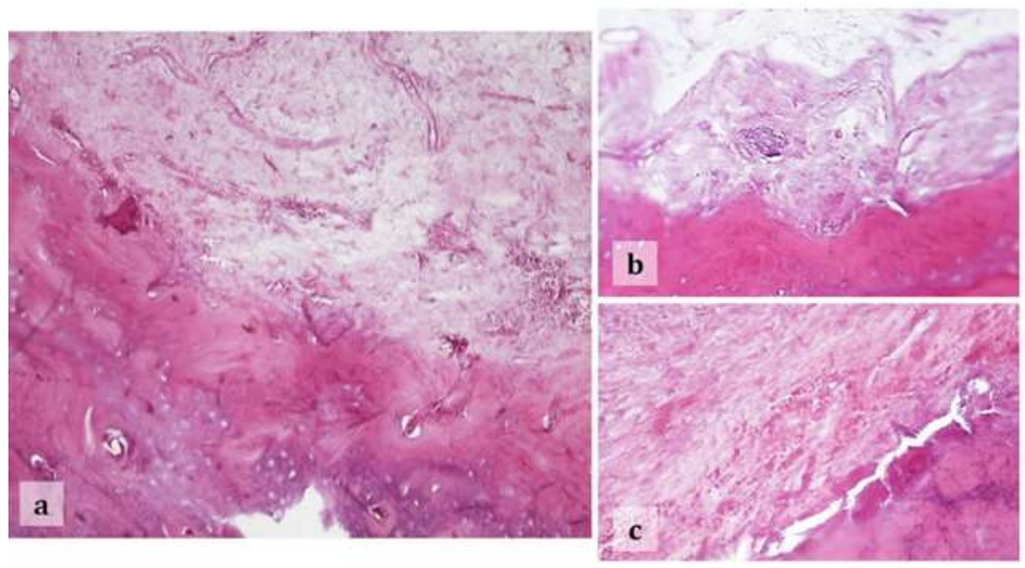


Figure 4. Histological aspects of the defect area, 4 weeks post-inoculation of the composite, a) Control group, where immature fibrous tissue and incipient osteoid deposits are observed, typical architecture for a mature fibrous tissue or a bone in the fibrous stage; b, c) Expiratory group, at the interface with the native cancellous bone, a progressive transition is highlighted, lacking fibrotic delimitation, associated with the onset of osteoblastic activity and the presence of fine bands of un-mineralized osteoid, ×20, ×40, HE

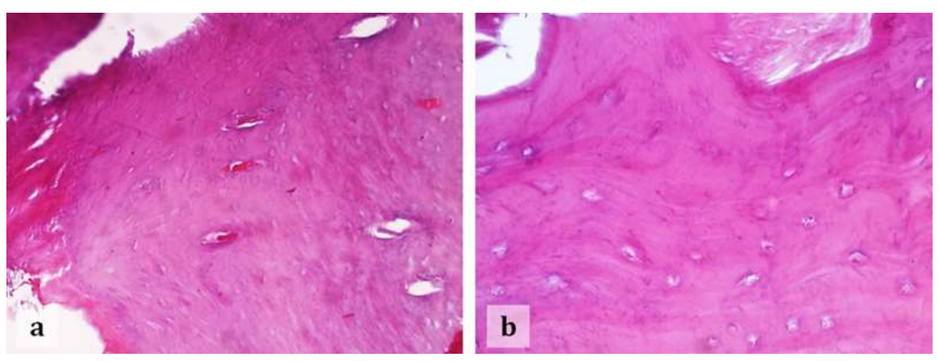


Figure 5. Histological aspects of the defect area, 20 weeks' post-inoculation, a) Control group, persistence of insufficiently organized bone tissue, with incomplete lamellar structures and limited remodelling activity; b) Expiratory group, formation of more mature, well-organized bone tissue, with evident lamellar architecture and osteocytes regularly arranged in the gaps, indicating an advanced process of bone regeneration and remodelling, ×20, ×40, HE.

Conclusion: Comparative analysis at one and three months shows that the human graft presents a more efficient bone integration and is less traumatic for the body, evidenced by a progressive decrease in the level of acid phosphatase. The xenogeneic graft induces a prolonged inflammatory reaction and an accentuated resorption, reflecting a lower biocompatibility.

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