Description of mechanical and biological factors affecting the bone-biomaterial(β tricalcium phosphate and chitosan), implanted in animal model

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INTRODUCTION:When designing a biomaterial, it is necessary to take into account both biological and mechanical factors that could affect its proper performance. From the biological point of view, when a biomaterial is implanted in bone tissues, it generates two interfaces: one between the foreign implanted material and the tissue surrounding it, and another one between inner parts of the material and the undegraded cells surrounding it. Cells neighboring bone surfaces, will try to invade the material to regenerate and reabsorb the defect created. This process is requires the production of type I and III collagen fibers, blood vessel growth, cell differentiation osteogenic and osteoclastogenesis which is the connection between the bone and the implanted material. However, these biological factors have a direct relationship with the mechanical factors involved in the healing process of injured tissues. The objective of this research is to obtain a synthetic, biocompatible and bioresorbable biomaterial. It is also easy to handle for the surgeon, and has a hardening time and moldability that facilitate its application. On the other hand, it has shown ability to stimulate bone formation at sites of non - union without adding other components.

METHODS: The biocomposite consisted of a solid phase (calcium phosphate and zinc oxide) and a liquid phase (chitosan), in an optimal combination that keeps physiological pH and temperature ranges, and a work hardening and time appropriate for clinical needs. The biomaterial of 5 mm in diameter was implanted bilaterally in the right parietal bones of 12 rats. The left sides were left without biomaterial and acted as controls. After 20, 40 and 60 days rats were sacrificed. Samples were prepared for histochemical studies with hematoxylin and eosin, Masson's trichrome, Gomori, Von Kossa; besides immunohistochemistry with actin and tartrate-resistant acid phosphatase (TRAP).

RESULTS: The obtained biomaterial had a pH between 6.5 and 8.5. The temperature was 20°C and the hardening time 7 mm. These parameters gave plasticity allowing handling "in situ" in a convenient time for intraoperative work. In all the studied periods, control defects remained unregenerated, showing only a thin layer of soft tissue covering them. The parietal bones with the biomaterial exhibit a strong inflammatory reaction (leukocytes and monocytes), which decreases over time, and simultaneously the material is incorporated in dense connective tissue continuous with the periosteum of neighboring bone surfaces. There is evidence of blood vessels growth, the presence of collagen fibers, reticular fibers, bone cells and TRAP-positive cells involved in phagocytosis of the biomaterial (see Figure 1).

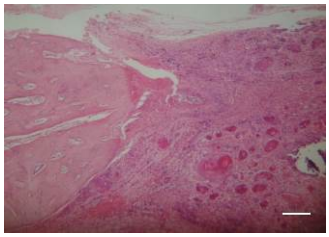

Fig. 1: The biomaterial (Bio), is including in connective tissue. At left border bone (B) and periostic tissue (P) are in close contact (20 xs). Haematoxylin-eosin. Scale bar= 50 micra.

DISCUSSION & CONCLUSIONS: A material withrecognized biocompatibility, osteoconduction, bioactivity, and complete reabsorption was obtained. The developed model behaved as critical defect size. The expected results are in accordance with those reported in the literature for the healing of critical size defects. Lack of regeneration in the defect control was observed. In the healing process, bone neoformation was evidenced in the defect implanted: resetting a vascular network, bone cells, forming a fibrillar network of collagen type I and type III, and initial deposit of material osteoid followed by the subsequent replacement by tissue bone. The biomaterial resorption seems to start on day 20 and is mediated by multinucleated giant cells similar to osteoclasts.

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