Porous metallic implants of Ti-13Nb-13Zr alloy

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INTRODUCTION: Biomaterials based on titanium and its alloys are widely used in dentistry and orthopaedics surgery due to their excellent mechanical properties and biological interaction. However, there are problems associated with the use of titanium as implant material. The high Young's modulus value when compared to the surrounding bone can cause problems of stress and subsequent dislocation of the implant [1]. To solve this problem have been developed osteoconductive porous materials for bone regeneration. One advantage in using materials with porous structure is the ability to allow a biological anchorage of surrounding tissues via bone ingrowth through the pores. Furthermore, the elastic modulus value can be adjusted between implant and trabecular bone values to match each other, thereby preventing bone resorption in the implant interface [2]. The Ti-13Nb-13Zr alloy studies has been developed due to its low elastic modulus combined with high values of mechanical strength and corrosion, compared to commercially pure titanium, besides its full biocompatibility [3].

METHODS: The Ti-13Nb-Zr alloy was obtained by mixing metal powders of Ti (268496, Sigma-Aldrich), Nb (262722, Sigma-Aldrich) and Zr (403296, Sigma-Aldrich) in stoichiometric proportions of the alloy. Dense samples of Ti-13Nb-13Zr alloy were studied as a control group for comparative purposes. The technique used to obtain porosity involves mixing the metal powder suspension, consisting of water and natural polymers (starch from corn, potato, rice and gelatin). The ratio of polymer used was 16% by weight of the total solids in 1g/mL of hot water. Immediately after filling the mold with the formed slurry, it was frozen for 12 hours. After this stage, the samples were placed in a kiln (38 ° C) prior to heat treatment (350 ° C/1h) and sintering (1300 ° C/3h). The samples were tested for cytotoxicity and for in vivo behaviour in rabbits (New Zealand White).

RESULTS: By X-Ray diffraction (XRD) analysis were observed the presence of α and β phases and by scanning electron microscopy (SEM) were observed the homogeneity in the microstructure. The values for mean particle diameter of natural polymers and the final implants porosity are shown in Table 1. No sample showed cytotoxicity in the test, enabling their use *in vivo*. After 7 weeks of repairing time, the rabbit's tibia with the implanted porous metallic material, showed good repair and penetration of bone tissue inside the pores.

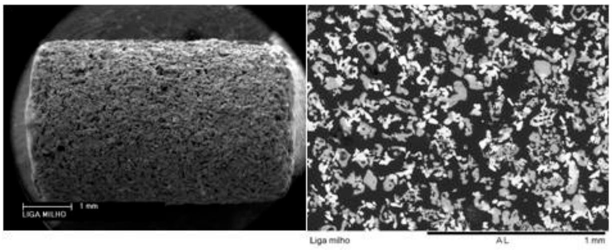

Fig. 1: Image of implant roughness surface, homogeneous microstructure and porosity.

Table 1. Mean particle diameter of the natural polymers and implants porosity.

	Particle size (µm)	Porosity (%)
Corn starch	16	61
Rice starch	11	62
Potato starch	55	64
Gelatin	225	68

DISCUSSION & CONCLUSIONS: Despite the high porosity, crystalline phases α and β form the Widmanstätten structure proving the good diffusion of β stabilizing elements of the Ti-13Nb-13Zr alloy. The methodology provided materials with high porosity and no contamination from the process. The obtained interconnected porosity of the implants, by this process, allowed bone ingrowth into and through the pores.

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ACKNOWLEDGEMENTS: CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) and FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo).