In vitro corrosion resistance and in vivo osseointegration testing of new TiAlNbTaMo alloy as candidate implant biomaterial

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Titanium-based alloys are used for the fabrication of biomedical implants, owing their corrosion resistance to the formation of a very stable oxide film that operates as a physical barrier that greatly hinders the release of metal ions into the surrounding biological tissues. Yet, minute amounts of metal ions are still released from the metallic material [1], and they are related to the formation of the oxide layer [2], to transient breakdown and reforming events of this film [3], and to metal debris [4]. In addition, acidification is considered harmful for the stability of the passive regime [5].

The biocompatibility performance of a Ti-based alloy is closely associated with its corrosion resistance, and efforts are made by the scientific community to optimize alloy composition, modify surface properties, and replace alloy elements that induce adverse physiological reactions. The development and characterization of new Ti-based alloys containing non-toxic elements has become a major objective due to awareness of systemic effects of corrosion from materials such as extra low interstitial (ELI) Ti-6Al-4V after reports that V produces harmful oxides [6], and Al may be related to Alzheimer disease [7]. In the quest for the development of new Ti-based alloys with optimized corrosion resistance and biocompatibility, Ti-6Al-7Nb alloy (now commercially available as ASTM F-1295) was proposed as a better alternative to Ti-6Al-4V due to improved corrosion and wear resistances [8]. Yet efforts are devoted to produce alloys with an elasticity modulus closer to that of living bone. In this study we characterized the in vitro corrosion and in vivo osteointegration of a new alloy Ti-6Al-2Nb-2Ta-1Mo by comparison to the Ti-6Al-7Nb alloy and to cp Ti. Potentiodynamic polarization and electrochemical impedance spectroscopy tests were performed in Hank's balanced physiological solution, whereas animal model testing was conducted by implanting cylindrical rods of these materials in the tibial crest of rabbits, whereas monitoring biochemical, histological and computed tomography data at different elapsed times after surgery.Both a higher degree of osteointegration and greater resistance to corrosion were observed for the new Ti-6Al-2Nb-2Ta-1Mo alloy, thus positively affecting the evolution of bone tissue repair.

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