Computational analysis of Titanium-Zirconium dental implant

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Background: Titanium zirconium (TiZr) alloys are a new choice for dental implants. Some studies showed that TiZr dental implants have better adaptation than titanium have. For example, TiZr implants have higher stability, similar osteoconductive properties, and more bone areas with in the chamber than Ti implants do, as indicated from a study in mini pigs [1]. However, case reports and research about TiZr dental implants are limited. None of studies investigate the biomechanical effects of TiZr dental implant especially on surrounding bone stress/strain. **Objective:** The aim of this study is to evaluate the biomechanical properties of TiZr dental implants by using finite element analysis (FEA). **Materials and methods:** This study uses computer-aided design software (SolidWorks 2007, SolidWorks Corporation, MA, USA) to construct a model of a bone block and a implant. After obtaining all of the models by applying Boolean operations to the variables, the corresponding solid models were exported from the CAD software to the commercial FE software ANSYS workbench 10.0 (Swanson Analysis Inc., Huston, PA, USA) to generate FE models. The interfacial condition between the implant and the cortical part of a bone block was set with a frictional coefficient of 0.45 for the cortical part, and 0.83 for the trabecular part. The contact areas among the implant, abutment, and screw were set with a frictional coefficient of 0.3. The implants and bone blocks were applied with homogeneous and isotropic elastic properties. The bottom of the bone block was fixed as the boundary conditions. The loading condition was applied on the top surface of the abutment. A vertical force and a 30 degree force of 190-N were applied as well. The element size was 0.4 mm for the implant and its components and the cortical part of a bone block while the element size for the trabecular part was 0.8 mm. Young's modulus and Poisson's ratio for all the materials are referred from Niinomi and Ho et al. [2, 3] and sawbones company. **Results**: All the peak values (maximum/minimum principle strain, maximum equivalent stress) of a Ti model are higher than those of a TiZr model, regardless of the loading type. In the vertical loading condition, the strain value of a TiZr model is 4.37% lower for the maximum principle strain, and 1.46% lower for the minimum principle strain, and 0.88% lower for the maximum equivalent stress. In the lateral loading condition, the strain value of a TiZr model is 4.84% lower for the maximum principle strain, and 5.21% lower for the minimum principle strain, and 5.47% lower for the maximum equivalent stress. **Conclusion**: A TiZr dental implant is able to reduce the peak strain value around the cortical region of the bone, therefore decrease the possibility of the bone loss due to overloading and indirectly reduce the risk of failure in an implant surgery. The TiZr implant reduces more strain/stress values on the lateral loading than those on the vertical loading. **Acknowledgement**: This study was supported by a grant (NSC 101-2314-B-039-022-MY3) (NSC 100-2815-C-039-032-B) from the National Science Council, Taiwan, and partly, by a research project (CMRPG8A0761) from Chang Gung Memorial Hospital, Taiwan.

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