

BONE REMODELLING FORMULATIONS TO AID DENTAL IMPLANT APPLICATIONS

Carina Carreira, Cátia de Sousa, Joana Gaspar, Paulo Bárto, Nuno Alves, Henrique Almeida, Carlos Capela and José Frazão
carina-carreira@hotmail.com; catiazita_sousa@hotmail.com; joanapgaspar@hotmail.com; pbartolo@ipleiria.pt; nuno.alves@ipleiria.pt,
henrique.almeida@ipleiria.pt, ccapela@estg.ipleiria.pt; j.b.frazao@gmail.com
Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, Marinha Grande, Portugal

Introduction

The most frequent surgical procedure performed upon humans is dental extraction. After this delicate procedure, one possible solution is without a doubt the employment of a complete or partial denture, which may be either fixed or removable devices.[1]

The body of the dental implant contacts the bone and soft tissue interfaces within the submucosal regions. These contact zones within or along the bone surface provides the areas for mechanical force transfer. Therefore, the implant-to-tissue interface becomes a critical area for force transfer and thereby the focal point for quality and stability of intraoral function.

Occlusal forces from the mastication of food are transferred from the intraoral prosthesis throughout the implant abutment and neck (connector) and into the implant-to-tissue interface region. These forces are dissipated through the associated tissues, and the quality of functional stability can be correlated with the relative interfacial stability (micromotion) over time. Two types of interfacial conditions have been described for functional dental implants: fibrous tissue integration and bone tissue integration.

Methodology and Results

In order to address the issue at hand and improve the dental implant / mandible interface, a set of computational algorithms are been developed based on bone remodelling schemes. Two initial bone remodelling schemes, Huiskes *et al* [2] and Beaupré *et al* [3] are been compared. For instance, Beaupré contemplates time factors and the superficial area of the remodelling bone.

Firstly, the elastic modulus of the mandible is defined as a function according to the bone density of a given patient. Then the simulation process begins with static structural simulations comparing all the existing dental implant designs (fig. 1) in the defected mandible region. From these simulations, it is possible to define a selection matrix based on the obtained deformation values and tensile stresses (fig. 2) contemplated by the mandible bone structure classifying the dental implant designs according to its performance.

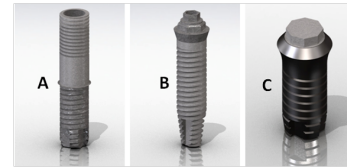


Figure 1 – Examples of existing dental implant designs.

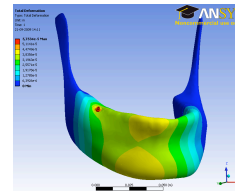


Figure 2 – Output results from the structural simulations.

This initial stage offers the first implant design to be submitted to the bone remodelling scheme. A 2D section of the dental implant and bone structure is made in order to perform the bone remodelling simulations. The bone remodelling process is then performed and from it a list of outputs regarding the bone remodelling in the implant-to-tissue interface. This process is repeated until all the dental implants have been submitted to the bone remodelling schemes. Based on the given results, another matrix is obtained and classifies the dental implants according to its capability of bone remodelling increasing the implant-to-tissue interface.

Discussion

The existence of a computational tool to support the designing process of a dental implant is extremely important. With this computational tool based on bone remodelling schemes and dynamic force cycles which will be incorporated in a future version, makes it possible to optimize the dental implant design and redesign it in order to improve its performance for a specific given situation. Also the bone remodelling schemes will be modified in order to contemplate 3D geometries.

References

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