DESIGN AND RAPID PROTOTYPING OF A NEW CRANIAL IMPLANT CONCEPT FOR CRANEOPLASTY

Carlos Asensio S. (1), Lilibeth A. Zambrano M. (2)

1. Valencian International University, Valencia, Spain; 2. South East Technological University, Department of Aerospace and Mechanical Engineering, Carlow, Ireland

Introduction

There is no standard procedure either for the design or the implantation of cranial implants. Also, there are no alloplastic cranial implants on the current market that are 100% biocompatible. The ideal material for all the heterologous cranioplasties has not been discovered yet [1]. Last, most of the state of the art is based on titanium screws fixation which has been associated with local inflammation, chronic infection and leaching of metal ions into local tissues after long-term skull implantation [2]. The aim of this work is to design and prototype a new concept that can be replicated in any area of the neurocranium, easy to attach without damage to the bones and has similar biomechanical properties to the bones that replace.

Methods

A comparison study of the models in the market was realized before the design. Later, an open source NRRD file [3] was used to segment the bone tissue in a patient missing a bone flap in the parietal-temporal area with *3D Slicer*, then, the design of the components of implant were made using *Blender*, the rapid prototyping of the different parts fabricated by additive manufacturing and, ultimately, assembled for testing, surgical planning, and visualization purposes.

Results

A new cranial model was prototyped made of PEEK and assembled into a 3D printed bio-model of the patient's neurocranium (Figure 1). This prototype contains different parts that sandwich together by anchors and a fixation system formed by self-locking zip ties placed on the meninges and washers that hold it together.

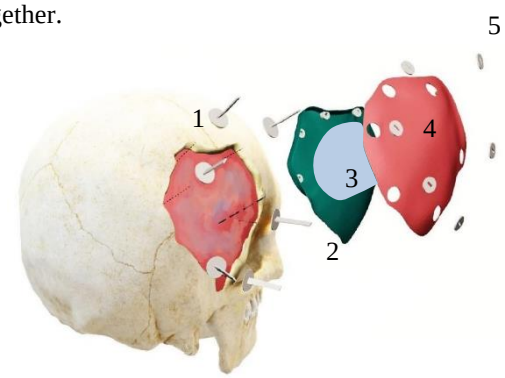

Figure 1: Exploded view of all the components of the cranial implant prototype. 1) Self-locking ties, 2) Inner layer, 3) Intermediate layer, 4) External Layer, 5)Washers.

Discussion

This new concept presents the innovation of a geometry formed by different layers that simulate the cortical and trabecular bone (diploe) in a sandwich-based concept setting it apart from those currently lacking on the market. It also has a fixation system designed for easy attachment to the neurocranium without the need of titanium screws. The parts that are Patient-specific can be 3D printed in PEEK while the fixation system can be manufactured by traditional methods using plastic injection molding. In addition, since the fixation system contain non-metallic materials it reduces the possible complications post-surgery, and in case it needs to be removed, it can be detached from the neurocranium without damaging surrounding tissue.

References

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