3-D PRINTING OF BIOCOMPATIBLE ENGINEERED POLYMERS FOR PERSONALIZED SKULL BASE RECONSTRUCTION IN ENDOSCOPIC SKULL BASE SURGERY

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Background

Endoscopic skull base surgery is a novel technique that allows the treatment of various intracranial pathologies through a minimally-invasive endonasal route. Its Achille's heel is the need to effectively reconstruct the skull base, to avoid a cerebrospinal fluid leak (CSF), which can cause intracranial infections leading to major sequelae and death. At present, the most used methods are not effective when the defect is large and geometrically complex. Innovations in material design and fabrication processes (biocompatible polymers, 3D printing) are raising the possibility of production of medical implants with high geometrical complexity.

Objectives

To develop a personalized, safe and relatively easy paradigm of skull base reconstruction that can be effective even in case of large and geometrically complex defects.

Methodologies

The clival defect was chosen as paradigm of a large and geometrically complex skull base defect (CSF leak rate reported in literature: 15-30%).

The project encompasses different lines of research:

1) development of a novel, patented process to produce porous biomaterials, with the possibility of precisely tuning its structural and mechanical features;

2) 3D printing of the scaffold modeled on the defect to repair via radiological imaging of the skull (CT DICOM images), segmentation and computer-aided design;

3) engineering of the scaffold: development of antibiotics-containing scaffold; enrichment with mesenchymal stem cells to achieve scaffold integration and tissue regeneration;

4) feasibility study in a preclinical setting: development of a cadaveric model to perform leak tests; definition of the algorithm to position and fix the scaffold.

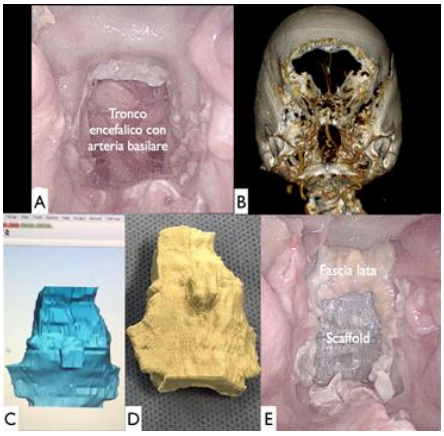

FIGURE 1. ALGORYTHM OF SKULL BASE RECONSTRUCTION TECHNIQUE. A, SIMULATION OF A CLIVAL DEFECT IN A CADAVER HEAD; B, RADIOLOGICAL RENDERING OF THE DEFECT; C, CAD PROJECT OF THE SCAFFOLD; D, 3D PRINTING OF THE SCAFFOLD; E, SKULL BASE RECONSTRUCTION WITH AUTOLOGOUS GRAFT (FASCIA LATA) AND THE

Expected Results and Impact

The main expected impact is the improvement in success rate of skull base reconstructions after expanded endoscopic approaches. This achievement will decrease treatment-related morbidity for many patients. In fact, treating complex intracranial, intradural pathologies via a transnasal endoscopic approach allows avoiding skin incisions and cranial osteotomies, and entails less brain manipulation. Moreover, this technique may be translated to bone reconstruction in other anatomical regions (i.e., maxillofacial) with possible great improvement of aesthetic and functional outcomes after oncological resections or maxillofacial reconstructions after trauma.