

CRANIO-FACIAL 3DIMENSIONAL IMAGING: AN AUGMENTED REALITY TOOL IN COMPUTER ASSISTED DIAGNOSIS AND TREATMENT PLANNING

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INTRODUCTION

A diagnostic and surgery simulation method is described. The workflow consists of different steps which start from CT/MRI exams and diagnostic imaging study, go through a computer assisted analysis and surgery simulation to conclude with a real-world simulation on high resolution 3D models of the patient. A set of new, innovative and multi-specialty instruments are here presented, focused on cranio-maxillo-facial surgery and orthodontics.

MATERIALS AND METHODS

The workflow starts with the use of **3Diagnosys[®] software** (3DIEMME[®] – Italy) to import the patient axial DICOM images to perform the diagnosis. The software consists of a set of essential functions that enable the surgeon to easily navigate, both in 2D images and 3D volume, inside the patient. 3Diagnosys[®] introduces a new approach in the daily surgery planning since it includes powerful instruments such as high resolution volume rendering, virtual endoscopy, 2D/3D MIP, MPR and CPR functions, working smoothly on low-end computers such as laptops. The software works also as an image distribution system because it can create CDs containing the complete software dedicated to a single patient; the “3Diagnosys[®] Patient CD” is self-executable and doesn’t require any installation, so that it can be read anytime, anywhere. 3Diagnosys[®] can be connected directly to the PACS system to retrieve the images from anywhere inside or outside the hospital. Since the software reads standard DICOM images it can be used to perform the diagnosis on any body part, as it is shown in the images below.

After the diagnostic phase the procedure goes on with the analysis and simulation step. This operation can be performed thanks to the **CMF Surgicase software** (Materialise – Belgium) for the cranio-maxillo-facial surgery. CMF Surgicase enables the surgeon to start performing a 2D/3D analysis based on classic or customized cephalometric measurements and proceeds with a “step-through” wizard which guides the clinician in the osteotomy and distraction procedures by choosing the type of surgery, indicating the pre-operative landmarks, placing the bone-distractors from a virtual library and repositioning the parts according to the desired result. All the tools enable a customized surgery approach. CMF Surgicase calculates a biomechanical model of each individual patient to simulate the soft tissues movement as a consequence of bone fragments repositioning, in this way it is possible to see the final outcome of the surgery starting from simple CT images. Thanks to a photo-mapping algorithm the patient picture can be superimposed to the CT soft tissues model and through a morphing approach the post-surgery patient face is evaluated.

The planning procedure can be concluded with a high resolution 3D model of the patient extracted from the original data where it is possible to test the osteotomies, pre-set the bone- distractors and bone plates before approaching the patient. The internal anatomy of the patient is reproduced as well.

Soft models can be built to reproduce tissues, blood vessels and aesthetic parts.

CLINICAL APPLICATION

This 3d imaging method enables clinicians (surgeons and orthodontists) to set up accurate diagnosis and precise treatment strategies, allows monitor changes over time and display final treatment results. In addition is possible to measure treatment outcomes accurately.

Some key features in this image environment are the capability to navigate in the volumetric data set in any orthogonal slice window and to calculate bone density according Hounsfield values.

Several pathological conditions may take advantages from an extensive application of this method.

Clinical protocols are in progress in cranio –facial anomalies and pathology:

- Ectodermal dysplasia
- Hemifacial Microsomia
- Craniofacial dysmorphism
- Severe maxillary bone atrophy
- Temporo-mandibular joints disorders
- Implant surgery
- Orthognatic surgery