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BIOMODELLING CERVICAL SPONDYLOTIC MYELOPATHY: EVALUATION AND SURGICAL PLANNING

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ABSTRACT

This work describes biomodelling process of a Cervical spondylotic myelopathy with the objective of performing a detailed patient condition evaluation and surgical planning. Biomodelling is a technique that aggregate medical image (from CT or MRI) processing procedures with additive manufacturing in order to obtain not only a digital 3D model from the diseased area but also total or partial physical 3D models that allow a better acknowledgement about damaged anatomical structures and easiest surgical procedures definition. In this particular case it becomes notorious by incising in small bone structures (cervical vertebrae) and soft tissues (intervertebral discs) that are not always easy to analyse through CT or MRI images. Through the obtained biomodels patient proper condition has been evaluated and surgical procedures have been defined and simulated, confirming biomodelling as a complementary diagnostic mean and a valuable surgery planning help.

Keywords: cervical spondylotic myelopathy, biomodelling, additive manufacturing, surgical planning.

INTRODUCTION

Cervical spondylosis is part of the aging process and affects most people if they live long enough. Degenerative changes affecting the intervertebral disks, vertebrae, facet joints, and ligamentous structures encroach on the cervical spinal canal and damage the spinal cord, especially in patients with a congenitally small cervical canal. Cervical spondylotic myelopathy (CSM) is the most common cause of myelopathy in adults(Tracy and Bartleson, 2010). It is a clinical entity that manifests itself due to static or dynamic compression of the spinal cord. The neurologic dysfunction may initially be mild with minimal disability, but with progressive spinal cord compression, patients may experience severe neurologic deterioration causing major disability. The treatment of cervical spondylotic myelopathy, in most instances, involves surgical decompression and fusion(Kang and Bohlman, 1996).

Biomodelling is a technique that has proven itself as a valuable tool in aiding patient's easiest evaluation under complex situations and to allow a better surgical procedures definition once the expected output can be analyzed before the surgery being performed(Queijo et al., 2012). This technique associates medical image processing, outputted from CT scanning in DICOM format, through predefined operations (algorithms) from specific software. These operations such as *threshold* and *paint/erase* allow the user to define which anatomical structures will be kept and which will be erased from the final model. That selection is performed by defining the pixel gray level range over which will be created a mask, slice by slice. By reconstructing the processed images with the correspondent mask it is possible to obtain a 3D digital model and export it under a *.stl* format.

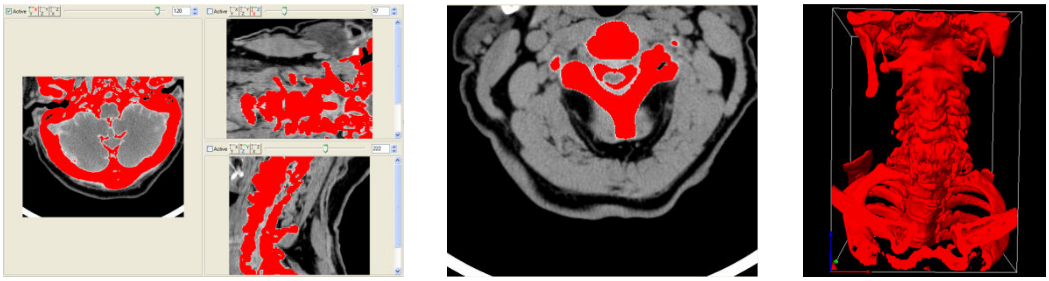

Fig. 1 - Image segmentation process: from the mask creation (left) to the 3D digital model (right)

Additive manufacturing devices work by building models layer by layer. Despite the several techniques and materials that can be used, our choice felt over 3DP technique that builds models in a composite similar to plaster by aggregating the powder with a water base binder. After completion, the obtained 3D physical model surfaces are stabilized by the impregnation of cyanoacrylate glue or epoxy resin, conferring, this way, a higher resistance to the model.

Fig. 2 - Biomodels building process.

RESULTS AND CONCLUSIONS

After concluded the biomodelling process it was possible to better observe the anatomical structures and the pathological induced morphological alterations related to a healthy cervical spine. Surgical procedures were defined based on complete and partial (sectioned) biomodels that allowed seeing were spinal cord were constricted and which kind of procedures were recommended to the patient's situation. A C4 cervical corpectomy with adjacent discectomies associated to a bone graft and anterior cervical plate fixations with pedicle screws in C3 and C5 was advanced as plausible treatment.

Despite the difficulty in processing soft tissues in small and complex anatomical structures, biomodelling was found to be a valid complementary diagnose mean and a helpful tool in assisting surgical procedures definition by reducing unexpected situations in surgery context.

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