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DEVELOPMENT OF CUSTOM PROSTHESES USING INCREMENTAL SHEET FORMING AND RAPID PROTOTYPING

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ABSTRACT

This project aims the development custom pre-operative aloplastic prosthesis, through change of data between computadorized tomography and CAD/CAM/CNC systems. To produce prosthesis will use the incremental sheet forming process - ISF. The target is make prosthesis that fit to the patient's body shape, providing functional stability and good aesthetics. Using polymer models, it is possible beforehand plan the surgery, studying the incision procedures. The results will evaluate making an assembly of titanium prosthesis and the damaged bone region model, made in polymer material, obtained through rapid prototyping. Dimensional and geometric analysis between digital and real models of prosthesis also will perform.

Keywords: prosthesis, customization, incremental forming, rapid prototyping.

INTRODUCTION

Sice 1980s, the CAD/CAM Technologies have been extensively applied to orthopedic, plastic, cranial, oral and maxilo-facial surgeries. A 3D CAD model is able, for example, to reproduce on computer and physical prototype (through rapid prototyping) a jaw of a patient and reveal the anatomical structure and its relationship to the surrounding tissues. The preoperative planning and use of prototypes allows obtaining parts with accuracy dimensions, reduces the operating time, minimizes the possibility of failure during rebuild, increases the treatment effectiveness and provides better aesthetic and functional results (Hou, 2012).

In addition to plan beforehand the restorative medical intervention, it is possible manufature customized prostheses according to the shape and dimensions of a specific patient, whereas the anthropometric differences between individuals are natural and each one requires a product with own characteristics, improving their performance and its usability (Ambrogio, 2005), (Lesic, 2004).
For the production of prostheses, emerges the incremental forming process, that has as advantages: a) possibility of using the same tool to manufacture different profiles without need of expensive dies and molds, b) low machine setup time, c) provides the manufacturwe of a variety of irregular shapes and asymmetrical, such as medical products highly customized (Hussain, 2009), (Dejardin, 2010), (Hussain, 2008).

RESULTS AND CONCLUSIONS

The tomography images allow the generation of 3D CAD vector model of the defective bone region. This digital model can be materialized in polymer using a 3D printer. The prosthesis is also designed according to 3D model and formed in CNC device. Following, an assembly is

made between the prosthesis and the polymer mold. The expected results are to obtain metallic prostheses (Ti-grade 2, titanium biomedical) perfectly fitted to the respective polymer models of the remaining parts of the bone, generated through rapid prototyping. The prostheses should be similar to their respective CAD model, presenting a uniform thickness variation and low surface roughness.

Fig. 1 - Polymer mold of skull and prosthesis in titanium sheet

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REFERENCES

[1]-Ambrogio G, Napoli L, Filice L, Gagliari F, & Muzzupappa M. Application of incremental forming process for high customized medical product manufacturing. J. Materials Processing Technology, 2005, 162-163, pp. , 156-162.

[2]-Dejardin S., Thibaud S. Gelin JC, Michel G. Experimental investigations and numerical analysis for improving knowledge of incremental sheet forming process for the sheet metal parts . Int Journal of Materials Processing Technology, 2010, 210 , 363-369.

[3]-Hou, JS, Chen M, Pan CB, Wang M, Wang JG, Zhang B. Application of CAD/CAM-assisted technique with surgical treatment in reconstruction of the mandible. Journal of Cranio-Maxillo-Facial Surgery , 2012, 1-6.

[4]-Hussain G, Gao L, Hayat N, Ziran X. A new formability indicator in single point incremental forming. . Int Journal of Materials Processing Technology, 2009, 209 , 4237-4242.

[5]-Hussain G, Gao L, Hayat N, Cui Z, Pang YC, Dar NU.Tool and lubrication for negative incremental forming of a commercially pure titanium sheet. Journal of Materials Processing Technology, 2008, 203 , 193-201. Lesic A, Bumbasirevic M. Ankle Fractures. Current Orthopaed, 2004, 18 , 232-244.