PRELIMINARY STUDY ON PHYSICAL RAPID PROTOTYPING IN ORTHOPAEDIC SURGERY

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INTRODUCTION

Orthopaedic surgeries are usually complex and time consuming. Therefore, minimizing the duration of the surgery, reducing the risk of complications during and post surgery are the main criteria involved while planning for surgery. This can be achieved using physical rapid prototyping (RP) modeling technique. RP involves fabrication of prototype model precisely produced from three dimensional medical image data.

Surgeons prefer to have a physical model of their patient's anatomy as it will enable them for better assessment in planning of surgery. RP produces complex features that help surgeons in making important decisions. Computed Tomography (CT) provides detail information relating to the geometry and physical properties of skeletal structures. CT images are effective to be used for orthopaedic related cases. Therefore, collaboration between engineers and surgeons are important to show the tremendous use of RP models in orthopaedic surgery.

METHODS

There are five main steps namely data acquisition, data processing, RP, post processing and measurement.

Data acquisition of 3D digital image was obtained from CT scanner. Data was exported to the DICOM format.

In the data processing step, firstly the CT images were imported into Mimics software. CT images were filtered, registered and aligned for its orientation. Secondly, selection of the CT images chosen represented the desired anatomical part of the body which is the pelvic and acetabular displaying the fracture clearly. Then region of interest was identified and selection of the threshold value was done to separate bone from the soft tissue. Different masks were obtained. After that, CT scatters causing streaking, image noise and image distortion was manually removed. The 3D model was calculated and generated. Magics software was used to improve the quality of the model. Finally, the digital model was converted to a Standard Triangulation Language (STL) format which is readable by the RP machine.

RP step involved the setting of parameters and build orientations before the production of the physical model. Fused Deposition Modeling (FDM) RP machine was used to construct the physical model. Post processing step was necessary for removal of support material. Ultrasonic bath was used for this reason. Then, the model was removed from the ultrasonic bath, rinsed in running water and dried. Finally, model was used for evaluation. A comparison in dimensional measurement between the 3D model and FDM model was done.

There were limitations and problems endured during data processing. One of the main causes was due to the CT scatters.

The model was given to the surgeon for comments and feedback relating to the use of the FDM model in planning of surgery.

RESULTS AND DISCUSSION

The measurement differences between the 3D model and FDM model was not that significant. The dimensional error was less than one percent which was negligible. The surgeon found the FDM model very useful as the model was helpful to study the case better and practice at the same time.

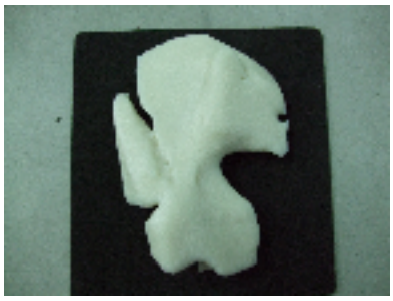

Figure 1: Acetabular Fracture FDM Model

CONCLUSIONS

FDM model is beneficent for the surgeon and patient. An RP model allows better visualization of the case that also makes planning of surgery easier and faster. RP model is also reliable for accurate assessment due to its high accuracy rate. This gives good reason to explore the use of RP models in orthopaedic surgeries.

ACKNOWLEDGEMENTS

The author would like to thank the support staff of Department of Engineering Design and Manufacture, Faculty of Engineering, University of Malaya especially Mr. Nasarizam for his assistance.

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