Preoperative Planning Utilizing 3D Printing

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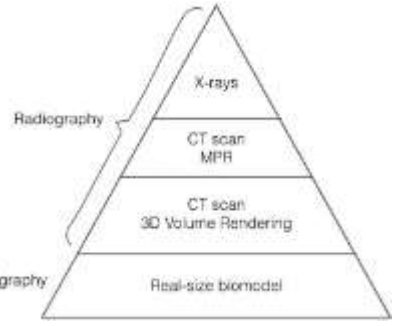
***Abstract*—Preoperative planning is important for surgeons to be able to reduce the length of surgical procedures and to increase the accuracy of procedures. 3D printing allows for a more complete view of the surgical area especially in relation to orthopedic surgeries. This paper will cover multiple kinds of surgery using 3D printing.**

I. Introduction

The applications of 3D printing in surgery has increased significantly in recent times though it is still not commonplace in most surgical communities. One such application is in preoperative planning. A model would be 3D printed to give the surgeon a better, complete view of the area that is to be repaired. This is important as many areas are not easily seen with 2D imaging such as CT, MRI, and Ultrasound scans. This lends 3D printing to be very helpful in situations where the anatomy is irregular and complex.

II. Methods

For preoperative planning, the accuracy of the 3D printed bio model is imperative. The surgeon must be able to fully trust the model's accuracy so that he/she may base their surgical plan and implant decisions on this. In order to create this model, many studies follow the same process. Before creating the model, the process must be started by scanning the desired area. This is usually done using CT scans with a segmentation of 1 mm but some studies also use ultrasounds and MRIs to create a more complete image based upon what they are scanning. Then using image processing software usually starting with blender processing and then mesh processing to create the 3D computer model which is then printed. The average time to print a 6 inch model is about 12 hours.



This model is used by the surgeon to create a surgical plan and to test out implants that he/she may want to use. In one study the accuracy of these models was tested by creating models of 16 dried cadaveric pelvises. Two observers would separately measure the section three times and they were compared. In another study, five surgeons used 3D printed models to plan their surgeries in 50 cases. The surgeons then rated their experiences from 1-10 in a standardized survey.

III. Results

In the study of the accuracy of 3D printed bio models, all measurements were found to have no statistical difference between the cadaveric pelvises and the 3D printed pelvises. This proved that the bio models were accurate enough to be used and relied upon by surgeons. In the second study, the surgeons' surveys were averaged together. Surgeons rated the accuracy of the model to be an 8.1, improved inventory management to be 8.2, and 8.9 would recommend this to other surgeons. The surgeons had a problem with the turn around time for these models rating it with a 4.6.

IV. Discussion

3D printing has proven to have some application in surgery though the position has not yet been decided. In complex surgeries where average anatomy is compromised, it is very useful in helping the surgeon visual the area to plan the surgery. Implants can also be tested on these models prior to surgery to allow for a better fit. Some disadvantages to this process are the time it takes to produce, the money it takes to buy a printer, the lack of surgical vocabulary with design engineers, and a lack of support from many surgeons who do not agree with this potential change.

As 3D printing becomes more common, many of these costs and reservations by surgeons will reduce over time. The major problem with this process is the reluctance of health care providers to support the use of bio models which can be seen as an unnecessary expanse when other scans have been used for so long. Until this is solved, it will be hard for 3D printing to disseminate.

References

[1] Kevin T, et al. "Putting 3D modelling and 3D printing into practice". *EDP Sciences*, 2017.
[2] Xin-Bao W, et al. "Printed Three-dimensional Anatomic Templates for Virtual Preoperative Planning". *Chinese Medical Journal*, 2015.
[3] Ralph M, et al. "The utility of 3D printing for surgical planning". *Journal of Neurosurgery*, 2017.
[4] Vaibhav B, et al. "A paradigm shift in surgical planning and simulation using 3Dgraphy". *Injury*, 2017.
[5] Patrick F, et al. "Three dimensional (3D) modelling and surgical planning in trauma and orthopaedics". *The Surgeon*, 2014.