3D Visualization of Cardiac Anatomy: New Approaches for Patient Education

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Introduction

3D Visualization is a technique that is being increasingly utilized in medicine. It is employed for diagnosis, intervention design, and patient education. It is expected of medical students and physicians to be able picture a heart in their mind. They often have little difficulty envisioning an anatomically correct heart, in addition to congenital heart defects. Patients and their families, however, may not always have this extraordinary ability. It is the patients' unfamiliarity with anatomy that provides motivation to develop innovative 3D tools that can be used to educate patients in clinical and hospital settings.

Design

The primary focus of this study is to recover 3D structures and images from CT Data. The data were acquired from a number of sources, including Cardiology Radiologists at St. Vincent Hospital Cardiovascular Imaging Department in Indianapolis, Indiana and the National Institutes of Health Cancer Imaging Archive.

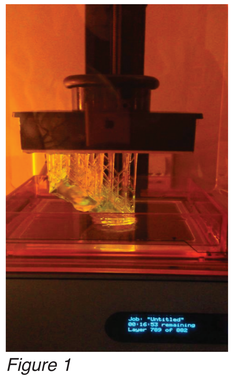

Figure 1

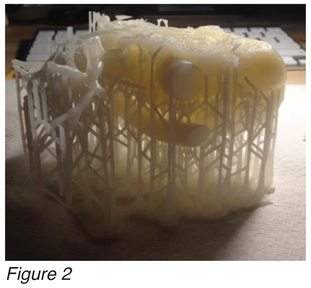

Figure 2

Methods

The study was performed in the Marian University College of Osteopathic Medicine 3D Visualization Laboratory. The CT data sets were analyzed with the 3D analytical software FEI Amira, and relevant anatomical structures, landmarks, and anomalies were identified and discriminated. The anatomical features were assembled to create a 3D print, and the projects were displayed via YouTube videos.

Figure 1: stereolithography print performed by a FormLabs1 3D printer
Figure 2: completed 3D print with support struts

Results

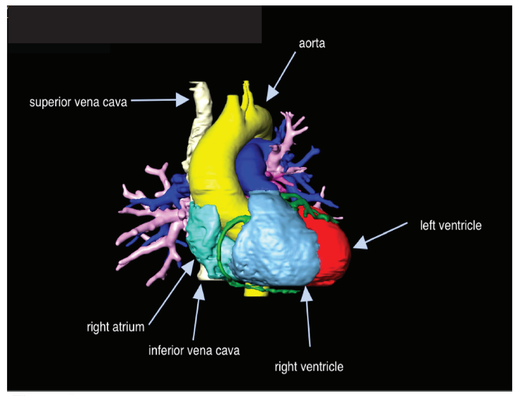

Figure 3

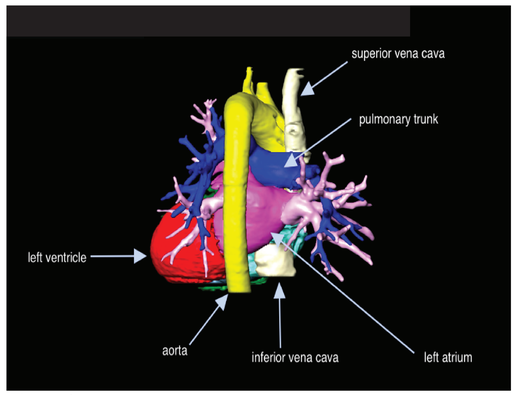

Figure 4

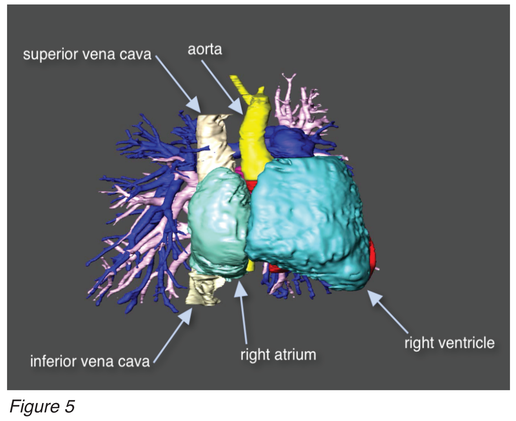

Figure 5

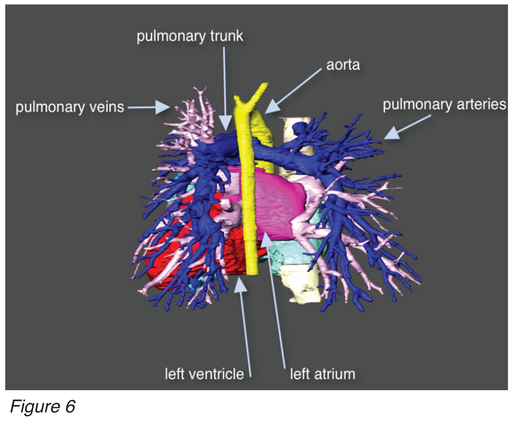

Figure 6

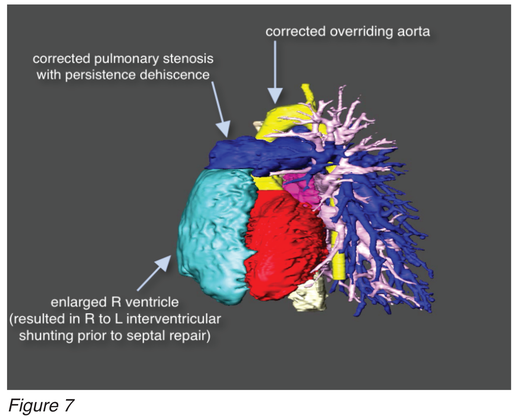

Figure 7

Anatomically correct heart
Figure 3: anterior view
Figure 4: posterior view

Tetralogy of Fallot post corrective surgery
Figure 5: anterior view
Figure 6: posterior view
Figure 7: lateral view

Results

We present two 3D studies: one of an anatomically correct heart, and the other of a heart after corrective surgery for the Tetralogy of Fallot congenital anomalies. Both projects have been replicated via 3D printing, and both have an associated YouTube video that enables patients to view the structures in three-dimension.

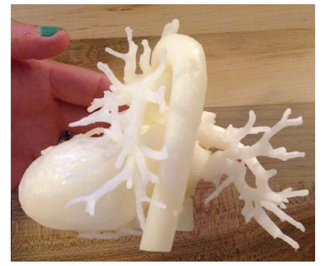

Figure 8

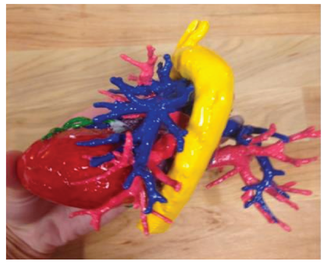

Figure 9

Conclusion

We find that by developing our skills in 3D Visualization, we can create more accurate, interactive, and detailed images of cardiac anatomy. Through our work, we realized that this technology is not only beneficial to the patient, but can also further supplement the studies of medical students and physicians. Our 3D Visualizations show great potential in advancing patient education and better enables health care providers to care for patients, both in clinical and hospital settings.

Future Developments

We are further pursuing and developing 3D visualization for patient education. We plan to promote the benefits and advantages to using various tools in health care for the benefit of patient care and comprehension. Furthermore, we hope to supplement clinical rotations with case-specific studies.

Figures 8 and 9: completed 3D print removed from support struts

YouTube Links:
3D Visualization of a Cardiac CT Study:
https://www.youtube.com/watch?v=Bwv596r1l1s

3D Visualization of Tetralogy of Fallot:
https://www.youtube.com/watch?v=DoyymOvaN-g 3D