Use of a Semi-Automated Cardiac Segmentation Tool Improves Reproducibility and Speed of Segmentation of Contaminated MRA Datasets

Tandon A1,2, Dyer AK1,2, Byrne N1, Velasco Forte MDLN3, Dillenbeck JM1,2, Greil GF1,2, Hussain T1,2
1University of Texas Southwestern Medical Center, Dallas, Texas, USA; 2Children’s Medical Center Dallas, Dallas, Texas, USA; 3King’s College London, London, UK

Background

• 3D printing is an evolving technology that is used increasingly in pediatric cardiology, especially in relation to interventional planning
• Use of patient-specific imaging for the creation of 3D printed models (3DPMs) requires the conversion of the imaging dataset into a stereolithography (STL) file, including image segmentation
• Segmentation is often time-consuming, and the consistency of the results of segmentation has not been thoroughly investigated in pediatric cardiology
• Patients with RVOT lesions often undergo intervention on the RVOT; for these patients, cardiac MRI (CMR) is indicated
• During these CMR studies, patients usually undergo contrast-enhanced MR angiography (MRA) to create accurate images of the vasculature
• Some right heart MRAs can become contaminated with left heart or other extraneous structures
• We compared a standard manual segmentation (MS) method to a semi-automated segmentation (SAS) method, designed specifically for cardiac segmentation, in terms of the conversion of the imaging dataset into a stereolithography (STL) file, including image segmentation

Materials and Methods

• Patients were included if they had undergone contrast-enhanced MRA as part of their CMR for RVOT evaluation
• Studies generally employed the high-temporal resolution “keyhole” MRA, with patients included if they had undergone contrast-enhanced MRA as part of their CMR for RVOT evaluation
• Further study of different software packages and different SAS techniques are required

Patient Characteristics

• 19 patients were analyzed based on the inclusion criteria
• 18 datasets were successfully segmented using both methods
• The dataset that failed SAS had both main and left pulmonary artery stents

Sample Differences

• Visual displays of differences demonstrate that most of the geometric disagreement occurred at areas where left heart contamination was removed

Acknowledgements

• AT, TH, and GFG were supported by the Early Career Research Award, Children’s Clinical Research Advisory Committee, Children’s Medical Center, Dallas.

Conclusions

• Semi-automated segmentation techniques can decrease the time needed to go from contaminated patient MRA datasets to 3D STLs, and make the process less variable and more reproducible
• For clean datasets, both methods seem acceptable
• Given that 3DPMs are promising tools for improving pre-procedural planning and education, the development of more robust segmentation tools would be beneficial
• Further study of different software packages and different SAS techniques are required to continue to push the field further.
• Improvements in MRA techniques allowing cleaner datasets would also aid the segmentation process

Materials and Methods

• Patients were included if they had undergone contrast-enhanced MRA as part of their CMR for RVOT evaluation
• Studies generally employed the high-temporal resolution “keyhole” MRA, with patients included if they had undergone contrast-enhanced MRA as part of their CMR for RVOT evaluation
• Further study of different software packages and different SAS techniques are required

Patient Characteristics

• 19 patients were analyzed based on the inclusion criteria
• 18 datasets were successfully segmented using both methods
• The dataset that failed SAS had both main and left pulmonary artery stents

Sample Differences

• Visual displays of differences demonstrate that most of the geometric disagreement occurred at areas where left heart contamination was removed

Acknowledgements

• AT, TH, and GFG were supported by the Early Career Research Award, Children’s Clinical Research Advisory Committee, Children’s Medical Center, Dallas.

Conclusions

• Semi-automated segmentation techniques can decrease the time needed to go from contaminated patient MRA datasets to 3D STLs, and make the process less variable and more reproducible
• For clean datasets, both methods seem acceptable
• Given that 3DPMs are promising tools for improving pre-procedural planning and education, the development of more robust segmentation tools would be beneficial
• Further study of different software packages and different SAS techniques are required to continue to push the field further.
• Improvements in MRA techniques allowing cleaner datasets would also aid the segmentation process