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A Case of 3D Printing Shaping the Future of Percutaneous Cardiac Procedures

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Background

- Paravalvular leaks (PVL) of surgically implanted aortic and mitral valves are a highly morbid complication [1,2].
- Repairing PVL surgically is associated with poor outcomes, such as persistent PVL and high mortality rates [3].
- Furthermore, these patients are often poor surgical candidates, due to age and accumulating comorbidities, making transcatheter repair a desirable alternative [4].
- Appropriate imaging prior to a percutaneous intervention to close a PVL is vital to success of the procedure.
- Complementing transesophageal echocardiography has been multi-slice computed tomography to assist with optimal device sizing and visualization of the anatomy [5].
- There are limitations with these imaging modalities, and three-dimensional (3D) printing of the patients desired anatomy has emerged as a new tool to help guide interventions with increased precision.
- 3D printing based on CT imaging datasets has been shown to improve outcomes among a variety of structural heart interventions [6,7].
- Here we report a case of a patient with a complex PVL which failed repair with conventional imaging, and returned to our structural heart team for 3D printing of his anatomy.
- His subsequent attempt using a 3D model for peri-procedural guidance aided with successful closure of his PVL.

Case Presentation

- A 69 year old male with a history of a surgically replaced aortic valve in 2004 presented to our hospital with symptoms of decompensated heart failure
- Found to have a severe PVL on a transesophageal echocardiogram
- Attempted PVL repair conducted with conventional imaging using 3D transesophageal echocardiography interprocedurally was unsuccessful.
- Unable to cross the defect due to irregular shape of the defect, and wire not supportive to deliver a catheter
- Procedure was terminated

Images

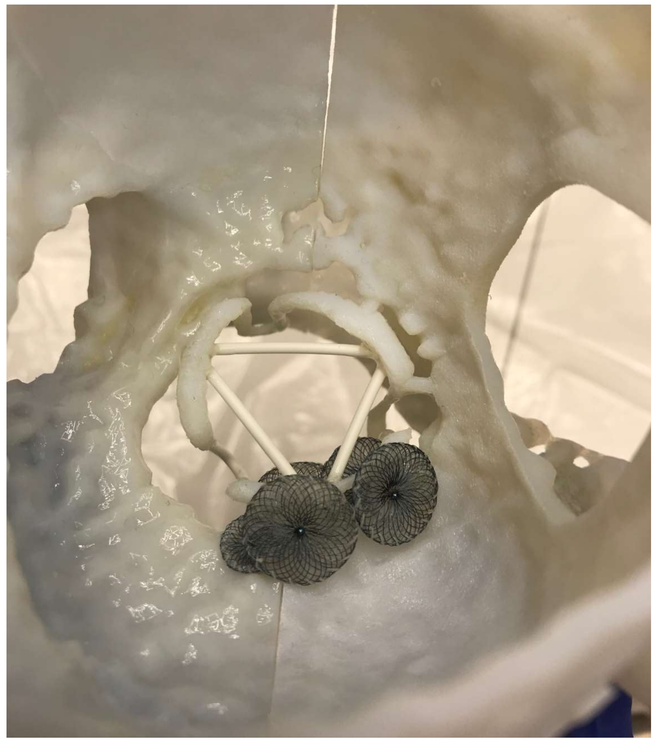

Image 1: A 3D Printed model of a patients paravalvular leak demonstrating ADO devices for plugging of a mitral valve leak

Image 2: Collage of 3D printed left atrial appendages demonstrating the unique characteristics of each one [8]

Case Presentation (cont.)

- 3D CT imaging with 3D printed model created subsequently to assist with a second attempt at percutaneous closure
- At second attempt with guidance and assistance peri-procedurally with 3D model, successfully closed the PVL with a 6/4 ADO II.
- No residual leak seen by aortogram or TEE.
- Resolution of symptoms after closure of PVL
- Patient discharged home following day without complication
- At most recent follow up, approximately 20 months after, patient still with no signs or symptoms of decompensated heart failure
- 20-month follow up echo confirming persistent successful closure

Conclusion

- Paravalvular leaks can present with signs and symptoms similar to decompensated heart failure, among other symptoms, such as hemolytic anemia.
- Conventional imaging, while improving, remains suboptimal for viewing patients anatomy from various angles.
- Three-dimensional CT imaging with 3D printing may help interventionalists with high-risk patients with challenging anatomy.
- Device selection, case planning, assistance with navigating defects are all aided with the use of 3D models.
- Further study is needed to determine full potential benefits, such as reduced contrast exposure, and reduced operation time.

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