9-1-2022

TCT-374 Structural Heart Intraprocedural Versus Nonprocedural Transesophageal Echocardiography: A Quantitative Analysis of Complexity

Ayman Alsaadi

Ali H. Ghandour

Abel Ignatius

Alexandra Martin

James Lee

See next page for additional authors

Authors

Ayman Alsaadi, Ali H. Ghandour, Abel Ignatius, Alexandra Martin, James Lee, Bobak T. Rabbani, Bryan Zweig, Sachin Parikh, Pedro Villablanca, Carl P. Wilson, Tiberio Frisoli, Brian P. O'Neill, William O'Neill, and Dee Dee Wang

TCT-372

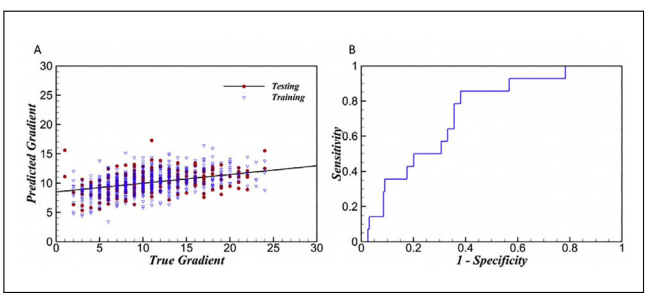
Predicting Pressure Gradient and Patient-Prosthesis Mismatch Using Artificial Intelligence for Transcatheter Aortic Valve Replacement

Anoushka Dasi,[1] Beom Lee,[2] Venkateshwar Polsani,[3] Pradeep Yadav,[3] Vinod Thourani,[3] Lakshmi Dasi[4]
[1]Ohio State University, Columbus, Ohio, USA; [2]Georgia Institute of Technology, Atlanta, Georgia, USA; [3]Piedmont Heart Institute, Atlanta, Georgia, USA; [4]Georgia Tech & Emory University, Atlanta, Georgia, USA

BACKGROUND Mean pressure gradient and prosthesis-patient mismatch (PPM) indicate the effectiveness of transcatheter aortic valve replacement (TAVR). We hypothesize that an artificial neural network (ANN)-based algorithm can predict post-TAVR pressure gradients and PPM based on preprocedural echocardiographic and computed tomography (CT) data.

METHODS A retrospective Institutional Review Board-approved study was conducted on a total of 1,072 patients (76.7 ± 9.4 years, 615 males and 457 females) with aortic valve stenosis and TAVR. Preprocedural CT measurements were preprocessed to extract 50 input features including diameter, perimeter, and patient history. Two ANNs were trained (training: n = 644, validation: n = 215) and then tested (testing: n = 213) to predict pressure gradient and PPM, respectively.

RESULTS The mean absolute error for pressure gradient was 3.326 mm Hg and 3.570 mm Hg for the training and test sets. The mean pressure gradients for the true and predicted output (Figure 1A) were 11.12 and 10.16 mm Hg, respectively. The predicted PPM classification's sensitivity and specificity values corresponding to threshold pressure gradient values varying from 8 mm Hg to 15 mm Hg were 92.5% and 44.4% (≥8 mm Hg), 74.8% and 51.2% (≥10 mm Hg), and 13.5% and 95.7% (≥15 mm Hg). A receiver-operating characteristic curve was generated from the training set with the threshold pressure gradient set as ≥20 mm Hg (Figure 1B). The area under the curve for a threshold of ≥10 mm Hg was 0.70, and for ≥20 mm Hg, it was 0.73.



CONCLUSION The ANN algorithm has demonstrated potential in predicting post-TAVR pressure gradient across the aortic valve as well as the incidence of PPM for patients with aortic valve stenosis.

CATEGORIES **STRUCTURAL:** Valvular Disease: Aortic

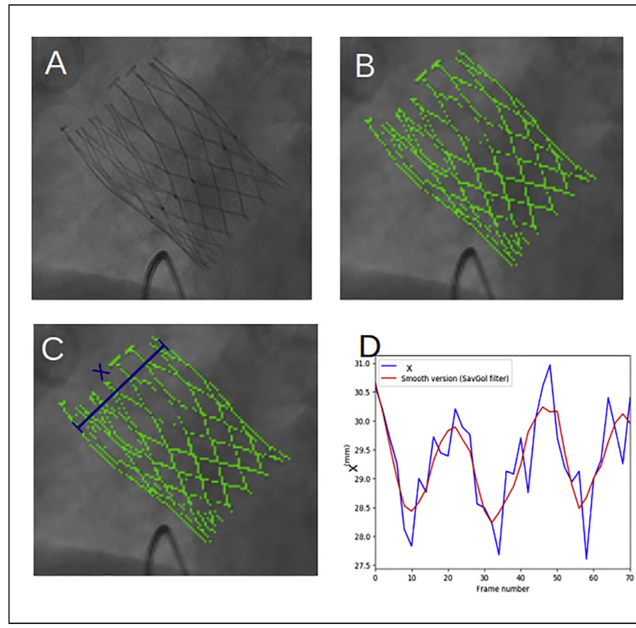
TCT-373

Using Deep Learning for TAVI Characterization in Angiographic Sequences for Extracting Radiomic Biomarkers of Prosthesis Deterioration

Laura Busto,[1] Cesar Veiga Garcia,[2] José A. González-Nóvoa,[2] Silvia Campanioni,[2] Alma Vivas,[2] Marcos Loureiro-Ga,[3] Victor Alfonso Jimenez Diaz,[4] Pablo Juan-Salvadores,[4] Jose Antonio Baz Alonso,[4] Andres Iñiguez Romo[5]
[1]Galicia Sur Health Research Institute, A Coruña, Spain; [2]Galicia Sur Health Research Institute, Vigo, Spain; [3]IIS Galicia Sur, Vigo, Spain; [4]Hospital Alvaro Cunqueiro, University Hospital of Vigo, Vigo, Spain; [5]Hospital Álvaro Cunqueiro, Vigo, Spain

BACKGROUND Transcatheter aortic valve implantation (TAVI) is being performed in increasingly younger patients; thus, the durability and deterioration of the prosthesis have become crucial aspects. According to the literature, the deterioration is directly related to the contractility of the prosthesis; therefore, being able to assess it from angiography in an unsupervised way may be of interest.

METHODS In order to take measurements from angiography (**Figure A**), the first step is identifying the prosthesis in each frame. For this, a U-Net model has been trained, an artificial intelligence architecture for image segmentation. Such a trained model can be used to make segmentation predictions in other images (**Figure B**). Once the prosthesis is detected, its diameter in the image projection (x in **Figure C**) can be extracted. Analyzing this parameter evolution through the sequence (**Figure D**) allows the computation of the contractility and, therefore, the study of prosthesis deterioration.



RESULTS The results of the segmentation have been evaluated in a test set of 460 images belonging to 19 patients, obtaining an average accuracy of 0.99 and precision of 0.73. **Figure B** shows an example of a result (obtained for the frame in **Figure A**). **Figure D** illustrates the evolution of the diameter, obtained throughout an angiographic sequence of 70 frames.

CONCLUSION Deep learning can be applied to angiographic sequences with TAVI prostheses to take measurements. An interesting parameter is the prosthesis diameter, whose temporal evolution allows the study of the contractility, which is directly related to the prosthesis deterioration.

CATEGORIES **STRUCTURAL:** Valvular Disease: Aortic

IMAGING IN STRUCTURAL HEART DISEASE III

Abstract nos: 374-378

TCT-374

Structural Heart Intraprocedural Versus Nonprocedural Transesophageal Echocardiography: A Quantitative Analysis of Complexity

Ayman Alsaadi,[1] Ali Ghandour,[2] Abel Ignatius,[3] Alexandra Martin,[3] James Lee,[2] Bobak Rabbani,[3] Bryan Zweig,[3] Sachin Parikh,[3] Pedro Villablanca,[3] Carl Wilson,[3] Tiberio Frisoli,[4] Brian O'Neill,[3] William O'Neill,[3] Dee Dee Wang[3]
[1]Henry Ford Health, Detroit, Michigan, USA; [2]Henry Ford Health System, Detroit, Michigan, USA; [3]Henry Ford Hospital, Detroit, Michigan, USA; [4]Henry Ford, Detroit, Michigan

BACKGROUND Transesophageal echocardiography (TEE) is an essential tool in many structural heart procedures, such as transcatheter mitral valve edge-to-edge repair (TEER). Interventional procedural TEE requires a unique skill set. This study aims to evaluate the complexity of interventional structural heart TEE used to guide TEER compared with standard of care (SOC) TEE studies performed at a single center.

METHODS A retrospective case-control analysis was performed of 200 patients who underwent TEE in the Henry Ford Health System. One hundred cases of interventional TEE-guided TEER were compared with 100 controls of SOC TEE. Complexity was quantified by the total duration of the procedure, the total number of images, and the number of 3-dimensional clips captured. The mean, median, and SD were compared between these 2 groups. Wilcoxon rank sum tests were used to evaluate statistical significance.

RESULTS One hundred intraprocedural TEE studies to guide TEER and 100 SOC TEE studies were analyzed. The mean duration of TEE procedures, the number of images, and the number of 3-dimensional clips were all significantly higher in the TEER group ($P < 0.0001$) (Table 1).

Variable	Response	Case (n = 100)	Control (n = 100)	*P* Value
TEE duration, min	Mean (SD)	120 (43.16)	23.7 (10.95)	**<0.0001**
	95% CI	(111.82-128.94)	(21.53-25.87)	
	Median [Q1, Q3]	116.00 [90.00, 142.50]	23.00 [15.50, 30.50]	
Number of images	Mean (SD)	201 (83.91)	74.3 (27.83)	**<0.0001**
	95% CI	(184.02-217.32)	(68.81-79.85)	
	Median [Q1, Q3]	193.50 [128.50, 253.00]	70.50 [57.00, 90.00]	
Number of 3D clips	Mean (SD)	33.4 (15.03)	5.0 (4.30)	**<0.0001**
	95% CI	(30.39-36.35)	(4.15-5.85)	
	Median [Q1, Q3]	32.00 [22.00, 43.50]	4.50 [2.00, 7.00]	

CONCLUSION Interventional TEE guidance for TEER is significantly more complex and more time-consuming than SOC TEE. This is the first large-scale study demonstrating objective differences between interventional and SOC TEE. This conclusion implicates the necessity of dedicated training programs for interventional imaging, in addition to the necessity of reviewing the current reimbursement codes to account for such a difference.

CATEGORIES STRUCTURAL: Valvular Disease: Mitral

TCT-375

Analysis of Flow Velocity/Aortic Pressure Curves in Patients With Aortic Stenosis, Before and After Transcatheter Aortic Valve Replacement: Prognostic Predictive Value for Objective Functional Improvement

Jose De la Torre Hernandez,[1] Gabriela Veiga Fernández,[2] Eyal Ben-Assa,[3] Julia Iribarren de la Riva,[4] Jose Iribarren Sarrias,[5] Fermin Sainz Laso,[1] Dae-Hyun Lee Hwang,[1] Cristina Ruisanchez Villar,[1] Piedad Lerena,[1] Tamara Garcia Camarero,[1] Maria Maza Fernandez,[6] Jose Cuesta,[1] Victor Fradejas,[1] Mercedes Benito Alfonso,[1] Sergio Barrera,[1] Jonathan Brown,[7] Aritz Gil Ongay,[1] Javier Zueco,[8] Jose Vazquez de Prada,[1] Elazer Edelman[9]
[1]Hospital Universitario Marques de Valdecilla, Santander, Spain; [2]Hospital Universitario Marques de Valdecilla, Soto de la Marina, Spain; [3]Massachusetts General Hospital, Boston, Massachusetts, USA; [4]School of Mathematics, University of La Laguna, Santa Cruz de Tenerife, Spain; [5]Hospital Clinico Universitario de Canarias, Santa Cruz de Tenerife, Spain; [6]IHCantabria, Santander, Spain; [7]MIT, Cambridge, Massachusetts, USA; [8]Marques de Valdecilla, Santander, Spain; [9]Massachusetts Institute of Technology/BWH (HMS), Cambridge, Massachusetts, USA

BACKGROUND The analysis of aortic flow velocity/pressure curves and their derived parameters would reflect the state of ventricular-aortic coupling and have been used to monitor ventricular afterload but have not been explored in patients with severe aortic stenosis. We sought to evaluate the potential predictive value of the parameters derived from the velocity/pressure curves for objective functional improvement after transcatheter aortic valve replacement (TAVR).

METHODS In a cohort of consecutive patients undergoing TAVR through femoral access, velocity/pressure curves were obtained from pressure recordings in the ascending aorta simultaneous with flow velocity recordings in the left ventricular outflow tract by echocardiography. From these, the alpha, beta, and GALA angles were calculated. A wide range of parameters derived from echocardiography were also collected (aortic gradient, aortic valve area, stroke volume, energy loss index, and valvulo-arterial impedance). Objective functional improvement of patients 6 months after TAVR was assessed using objective tests (6-minute walk test + N-terminal pro-B-type natriuretic peptide). Clinical follow-up was done at 2 years.

RESULTS Of the 102 patients studied, 84 (82%) showed objective functional improvement at 6 months. The 2-year mortality of these patients was significantly lower than that of those who did not improve (8% vs 28%; $P = 0.01$). In the univariate analysis, the alpha angle, arctang (Pressure at Vmax - Pressure at Vo/Vmax), was associated with such objective improvement, confirming its independent predictive value. The cutoff value was 5 with an area under the curve of 0.7 in the global cohort and 0.8 in the low aortic gradient subgroup. On the other hand, the mean aortic gradient showed an area under the curve of 0.55, similar to that of the aortic valve area, and 0.52 for the valvulo-arterial impedance

CONCLUSION The analysis of the aortic flow pressure/velocity curves through the alpha angle parameter makes it possible to estimate the degree of objective functional improvement after TAVR much more precisely than the classic parameters used to assess the severity of aortic stenosis. Objective functional improvement portends an important prognostic value after TAVR.

CATEGORIES STRUCTURAL: Valvular Disease: Aortic

TCT-376

Holographic Mixed Reality Image Analysis vs CT Reconstruction for Assessment of Aortic Valve Complex in Patients Undergoing TAVR

Michela Bonanni,[1] Marco Desiati,[2] Giulio Russo,[3] Gianluca Massaro,[1] Daniela Benedetto,[4] Sofia Schino,[1] Marco Di Luozzo,[5] Enrica Mariano,[6] Massimo Marchei,[1] Maurizio Taramasso,[7] Francesco Maisano,[8] Giuseppe Sangiorgi[2]
[1]Policlinico Tor Vergata, Rome, Rome, Italy; [2]University of Rome Tor Vergata, Rome, Rome, Italy; [3]Policlinico Gemelli, Rome, Foggia, Italy; [4]Tor Vergata University Hospital Rome, Milan, Italy; [5]Az. Univ. Policlinico Tor Vergata, Rome, Italy; [6]University Tor Vergata, Rome, Italy; [7]Herzzentrum Hirslanden, Zurich, Switzerland; [8]San Raffaele Hospital, Milan, Italy

BACKGROUND The use of 3-dimensional (3D) modalities for optimal preprocedural planning in transcatheter aortic valve replacement (TAVR) is essential to ensure procedural success. However, current methods are based on a 2-dimensional screen view that may hamper the understanding of real anatomy. The aim of the present study was to evaluate the accuracy and reproducibility of a mixed-reality (MxR) holographic software image analysis, which may improve preprocedural planning by allowing real 3D visualizations with holographic replicas of aortic valve complex.

METHODS Standardized automated 3D computed tomography (CT) measurements were obtained for aortic valve complex and included aortic annulus (AA, both perimeter and area), sinus of Valsalva, left ventricle outflow tract (LVOT, both perimeter and area), sinotubular junction, coronary height, and ascending aorta. These measurements were compared with those obtained by 2 independent operators using MxR semiautomatic tools able to perform the entire transformation process from CT Digital Imaging and Communications in Medicine files to 3D holographic rendering. Interobserver difference and intraclass correlation was calculated.

RESULTS Forty-seven consecutive patients undergoing TAVR were included. The interobserver difference was below 10%. The intraclass correlation was >0.75 for all measurements, except the distance between the AA plane and the left coronary artery ostium and the LVOT area (0.609, respectively). The MxR annulus mean diameter ($r = 0.95$), annulus perimeter ($r = 0.93$), and annulus area ($r = 0.89$) were highly correlated with CT cross-sectional measurements ($P < 0.0001$, respectively). No significant differences between CT and MxR were observed regarding the annulus perimeter (MxR 76.33 $\pm$ 6.71 mm, CT 76.45 $\pm$ 7.32 mm) and the annulus mean diameter (MxR 24 $\pm$ 2.12 mm, CT 23.09 $\pm$ 2.09). However, MxR measurements overestimated the aortic annulus area compared with CT (449.9 $\pm$ 81.44 mm^2 and 430.1 $\pm$ 81.81 mm^2, respectively).

CONCLUSION Utilization of MxR imaging allows highly reproducible measurements showing good correlation with CT to determine preprocedural aortic valve complex assessment. Our results suggest that