JACC: CARDIOVASCULAR IMAGING, VOL. 6, NO. 2, 2013
FEBRUARY 2013:274–80

patient, and they are not obtained intuitively. We present a step-by-step approach that can be used to create double-oblique multiplanar reconstructions which are exactly aligned with the lowest insertion points of the 3 coronary cusps (Fig. 1). This approach is not limited to a specific software product and can be used with any software package which allows generation of double-oblique multiplanar reconstructions from contrast-enhanced CT data sets.

Stephan Achenbach, MD,* Annika Schuhbäck, MD, James K. Min, MD, Jonathon Leipsic, MD

*University of Erlangen, Department of Cardiology, Ulmenweg 18, 91054 Erlangen, Germany. *E-mail: stephan.achenbach@uk-erlangen.de*

http:dx.doi.org/10.1016/j.jcmg.2012.06.015

Please note: Dr. Min has served on the medical advisory board for GE Healthcare and Arineta, has received research support from GE Healthcare, Philips Healthcare, and Vital Images, has served on the Speaker's Bureau for GE Healthcare, and holds equity interest in TC3 and MDDX. Dr. Leipsic has a relationship with Edwards Lifesciences. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

REFERENCES

1. Schoenhagen P, Kapadia SR, Halliburton SS, Svensson LG, Tuzcu EM. Computed tomography evaluation for transcatheter aortic valve implantation (TAVI): imaging of the aortic root and iliac arteries. J Cardiovasc Comput Tomogr 2011;5:293–300.
2. Willson AB, Webb JG, Labounty TM, et al. 3-dimensional aortic annular assessment by multidetector computed tomography predicts moderate or severe paravalvular regurgitation after transcatheter aortic valve replacement: a multicenter retrospective analysis J Am Coll Cardiol 2012;59:1287–94.
3. Jilaihawi H, Kashif M, Fontana G, et al. Cross-sectional computed tomographic assessment improves accuracy of aortic annular sizing for transcatheter aortic valve replacement and reduces the incidence of paravalvular aortic regurgitation. J Am Coll Cardiol 2012;59:1275–86.
4. Tzikas A, Schultz C, Van Mieghem NM, de Jaegere PP, Serruys PW. Optimal projection estimation for transcatheter aortic valve implantation based on contrast-aortography: validation of a prototype software. Catheter Cardiovasc Interv 2010;76:602–7.
5. Kasel AM, Cassese S, Leber AW, von Scheidt W, Kastrati A. Fluoroscopy-guided aortic root imaging for TAVR: "follow the right cusp" rule. J Am Coll Cardiol Img 2013;6:274–5.

Stenosis of a Mechanical Mitral Valve Prosthesis by Eccentric Paraprosthetic Aortic Regurgitation

Compared with 2-dimensional (2D) transesophageal echocardiography (TEE), 3-dimensional (3D) TEE, providing realistic visualization of the valve prosthesis in the context of the surrounding anatomy, promises to provide even more accurate evaluation of prosthetic valve malfunction.

This will be exemplified by the following case of a 57-year-old man who was referred to our hospital with progressive shortness of breath. He had an extensive cardiac history, including 3 aortic valve replacements after aortic valve endocarditis ending with a mechanical bileaflet aortic valve prosthesis (AVP) (25 mm, St. Jude Medical Master HP, St. Paul, Minnesota) 14 years ago. In addition, he received a mechanical bileaflet mitral valve prosthesis (MVP) (31 mm, St. Jude Medical) 12 years ago. All cardiac surgery was performed in institutions elsewhere.

Transthoracic echocardiographic (TTE) measurements suggested relevant MVP obstruction with a mean pressure gradient (PG) of 9.2 mm Hg and a maximum PG of 29.8 mm Hg (Vmax: 273 cm/s) using the simplified Bernoulli equation. Pressure half time was increased with 163 ms. There was no obvious reason for MVP stenosis like thrombosis or pannus formation. However, in the presence of unrestricted opening motion of both MVP leaflets, there was suspicion of an asynchronous motion pattern of the 2 leaflets. At the AVP, we found moderate to severe paraprosthetic aortic regurgitation (ppAR) with a very eccentric jet directed straight toward the MVP. Beside these findings, systolic PG over tricuspid valve was 57.9 mm Hg, and 6-min walk test was limited with only 124 m.

TEE measurements and leaflet motion confirmed dynamic MVP obstruction with a mean PG of 9.3 mm Hg (Vmax: 246 cm/s) and an increased pressure half time of 229 ms. Detailed visualization of MVP revealed premature closure of the posterior leaflet of MVP (Fig. 1). Color Doppler imaging clearly showed the eccentric ppAR jet striking the 2 MVP leaflets, forcing the posterior disk to close prematurely, whereas the anterior disk stayed wide open until the end of diastole. 3D imaging clearly visualized the MVP in a realistic en face perspective with the asynchronous disk closure demonstrated in direct comparison to fluoroscopy (Fig. 1).

Importantly, 3D-TEE demonstrated the MVP implanted in an antianatomic orientation with a 45° counterclockwise rotation from the anatomic orientation toward the left atrial appendage (Fig. 1), with the consequence that the ppAR jet did not strike the anterior leaflet in a frontal direction but from the side with a relevant portion of the ppAR jet impinging directly on the posterior leaflet (streamline of jet flow with asterisk). Although the phenomenon of diastolic leaflet oscillation caused by aortic regurgitation that impinges on the anterior or posterior mitral leaflet and impedes its normal opening pattern has been discussed (1), such a mechanism was never considered before to appear also in mechanical bileaflet MVP.

Because a surgical intervention would have been the fifth open-chest heart surgery and based on the hypothesis that mitral stenosis was not a primary MVP dysfunction, but a secondary malfunction caused by the ppAR jet, we decided to close the paraprosthetic AVP leak by percutaneous occluder implantation. In a catheter intervention via a femoral arterial access, 2 occluder devices (Amplatzer Vascular Plug III 12 × 5 mm and 10 × 5 mm) were successfully implanted into a slitlike paraprosthetic AVP leak (Fig. 2).

After device closure, TTE revealed a significantly reduced mean PG over the MVP of 5.0 mm Hg. Maximum PG was decreased to 14 mm Hg (Vmax: 160 cm/s) and pressure half time was also significantly reduced to 77 ms. Both TTE and TEE demonstrated residual mild-to-moderate ppAR, but with the direction of the regurgitant jet changed in a way not impinging on the MVP leaflets anymore (Fig. 2). Along with this, an almost perfectly synchronous opening and closing pattern of the 2 MVP leaflets could be observed as demonstrated by 2D- and 3D-TEE and fluoroscopy (Fig. 2).

After device closure, the patient's clinical condition improved significantly with reduction of dyspnea from New York Heart Association functional class IV to class I to II, improvement of his 6-min walk test to 365 m, and decrease of systolic PG over the tricuspid valve to 23.0 mm Hg.

In conclusion, in this first report of a case of mechanical MVP obstruction caused by an eccentric ppAR jet, MVP obstruction could be successfully eliminated through percutaneous device closure as an in vivo proof of concept and 3D-TEE visualization was found to be crucial for understanding the mechanism of obstruction.

Figure 1. Asynchronous Mitral Valve Prosthesis Leaflet Closure Caused by Eccentric Paraprosthetic Aortic Regurgitation

Visualization of the asynchronous mitral valve prosthesis (MVP) leaflet closure pattern in 2-dimensional transesophageal echocardiography (TEE) **(A to F)** (Online Video 1), 3-dimensional TEE **(G to I)** (Online Video 2), and fluoroscopy **(J to L)** (Online Video 3). After synchronous opening of both MVP leaflets **(A, D, G, and J),** the posterior leaflet (post) closes prematurely while the anterior leaflet (ant) stays open until end-diastole **(B, E, H, and K)** (electrocardiographic time marker: **red** = present image; **white** = previous images). Color Doppler imaging shows the eccentric paraprosthetic aortic regurgitation jet striking the posterior MVP leaflet **(E).** Three-dimensional images show the MVP in an en face perspective from the left atrium with a 45° rotation from an anatomic orientation **(G)** and the assumed streamlines of paraprosthetic aortic regurgitation flow striking the anterior and posterior MVP leaflets **(H)**. Ao = aorta; AVP = aortic valve prosthesis; LA = left atrium; LAA = left atrial appendage; LV = left ventricle.

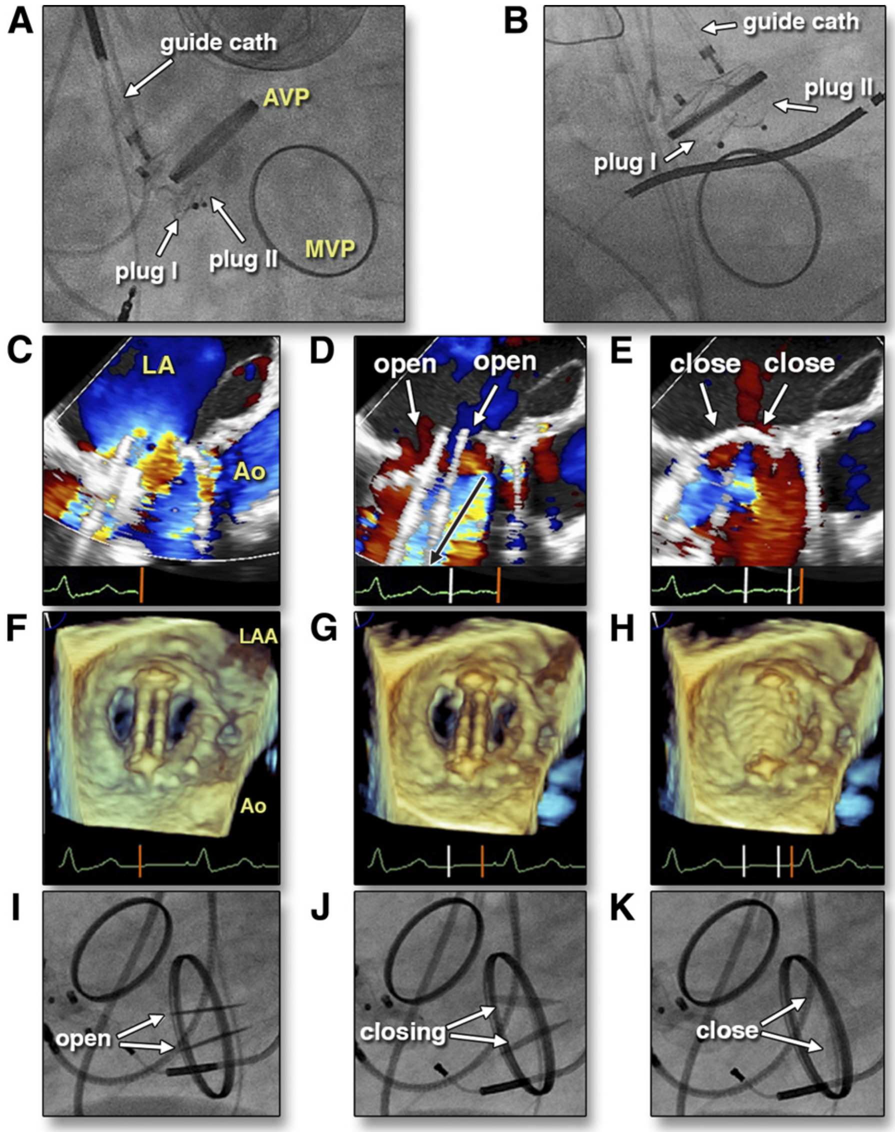

Figure 2. Synchronous Mitral Valve Prosthesis Opening and Closing Pattern After Device Closure of Paraprosthetic Aortic Regurgitation

Visualization of the same set of 2-dimensional TEE (Online Video 4), 3-dimensional TEE (Online Video 5), and fluoroscopic images (Online Video 6) after device closure illustrating synchronous MVP opening and closing pattern. **(A, B)** Fluoroscopic imaging during percutaneous occluder implantation show the 2 occluder devices successfully deployed in the paraprosthetic leak. Abbreviations as in Figure 1.

Thomas Buck, MD,* Björn Plicht, MD, Philipp Kahlert, MD, Thomas Konorza, MD, Raimund Erbel, MD

*West German Heart Center Essen, Department of Cardiology, University Hospital Essen, University Duisburg-Essen, Hufelandstrasse 55, 45122 Essen, Germany. *E-mail: thomas.buck@uk-essen.de*

http:dx.doi.org/10.1016/j.jcmg.2012.11.008

Please note: Dr. Konorza is now deceased.

REFERENCE

1. Johnson AD, Gosink BB. Oscillation of left ventricular structures in aortic regurgitation. J Clin Ultrasound 1977;5:21–4.

APPENDIX

For supplementary videos and their legends, please see the online version of this article.