Intraoperative 3-Dimensional Transesophageal Echocardiography Assessment of Valvular Geometry After Implantation of Basal Annuloplasty of Cardia Externally Device for Ischemic Mitral Regurgitation

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A 47-year-old man in New York Heart Association (NYHA) class III presented for implant of the Basal Annuloplasty of Cardia Externally (BACE) device (Phoenix Cardiac Devices, Cary, NC), as part of a clinical trial (NCT02701972) for ischemic mitral regurgitation (MR). The patient gave consent for publication of this case.

The preoperative transthoracic echocardiogram reported a left ventricular (LV) ejection fraction of 30%, moderate MR (Carpentier type IIIb), and mild tricuspid valve regurgitation (TR).

The intraoperative transesophageal echocardiography confirmed functional mild to moderate MR due to systolic bileaflet restriction (Supplemental Digital Content 1, Video 1, http://links.lww.com/AACR/A188). The anteroposterior mitral valve (MV) diameter was 3 cm, and the posteromedial to anterolateral diameter was 4.2 cm. LV ejection fraction was 23%. Trace TR was noted.

After a standard sternotomy, the base of the heart circumference was measured 34 cm (Figure 1A). A 35-cm BACE device (Figure 1B) was inserted around the heart and secured at the atrioventricular groove (Figure 1C). The BACE chambers were filled with 4 mL saline solution without a significant change in MR. Four more milliliters were added without further changes in MR grade (Supplemental Digital Content 2, Video 2, http://links.lww.com/AACR/A189). The anteroposterior MV diameter increased slightly to 3.1 cm, and the posteromedial to anterolateral diameter decreased to 3.7 cm. Three-dimensional (3D) MV reconstruction by semiautomated Mitral Valve Navigation software (Philips, Andover, MA) demonstrated a reduction in the tenting volume, height, and annulus area with a change to a more circular shape (Figure 2). Tricuspid valve (TV) annulus was reduced from 4.2 to 2.9 cm in the midesophageal 4-chamber view. On 3D TV multiplanar reconstruction analysis (Figure 3) (Philips 3DQ software; Philips, Andover, MA), the annular maximum and minimum diameters decreased from 4.9 and 3.2 cm to 2.9 and 2.3 cm after BACE implant, respectively. Biventricular systolic function was preserved.

The patient was extubated the same day, discharged from the intensive care unit on postoperative day 2 and home on day 5. LV ejection fraction and MR grade were unchanged at 6-month follow-up with an improvement in NYHA class II.

DISCUSSION

The mechanism of ischemic MR is well described.[1,2] Its management remains a clinical challenge and surgical intervention carries a 3%–6% mortality.[3]

The BACE is a new extracardiac device[4] for the treatment of moderate and severe ischemic MR that may be implanted on a beating heart. The device comprised a circular silicone band with 4 inflatable chambers, belt loops to secure it to the epicardium, and subcutaneous ports connected to the chambers by silicone tubing (Figure 1B). It is available in 21- to 41-cm circumferences (in 1-cm increments) and can be oversized by 1 cm above the measured basal cardiac circumference. It is advanced to the atrioventricular groove and secured in place with prolene sutures (Figure 1C). It wraps the base of the heart, decreasing the size of the MV and TV annuli and bringing the basal myocardial segments closer to improve MV leaflet coaptation and prevent further dilation.[5] Adding or removing saline into the 4 inflatable chambers adjusts the circumferential force applied by the device.[6] Indications and contraindications to BACE implant are summarized in the Table. Previous coronary artery bypass grafting is an absolute contraindication to device implantation. When coronary artery bypass grafting is performed at the time of BACE implant, the device would be secured before performing the anastomoses.

The aim of the intraoperative transesophageal echocardiography examination is to confirm eligibility for the procedure, exclude absolute contraindications, guide inflation of the BACE ports, and detect possible complications (Supplemental Digital Content 3, Supplemental Table 1, http://links.lww.com/AACR/A193). Preoperative hemodynamic conditions should not affect accurate estimation of MR severity. BACE chambers may become visible once inflated as a hypoechoic, ill-defined, extracardiac structure containing air bubbles adjacent to the basal LV segments in the midesophageal 4-chamber view. Saline solution in 2-mL increments is added to all BACE chambers up to a maximum improvement in MR severity. The degree of TR is not considered in guiding chamber inflation. In our case, no significant MR improvement was noted with inflation between 6 and 8 mL (Supplemental Digital Content 2, Video 2, http://links.lww.com/AACR/A189).

3D MV and TV assessments are not mandatory to guide BACE implant; however, in our case, they provided a better understanding of the effect of the BACE on MV and

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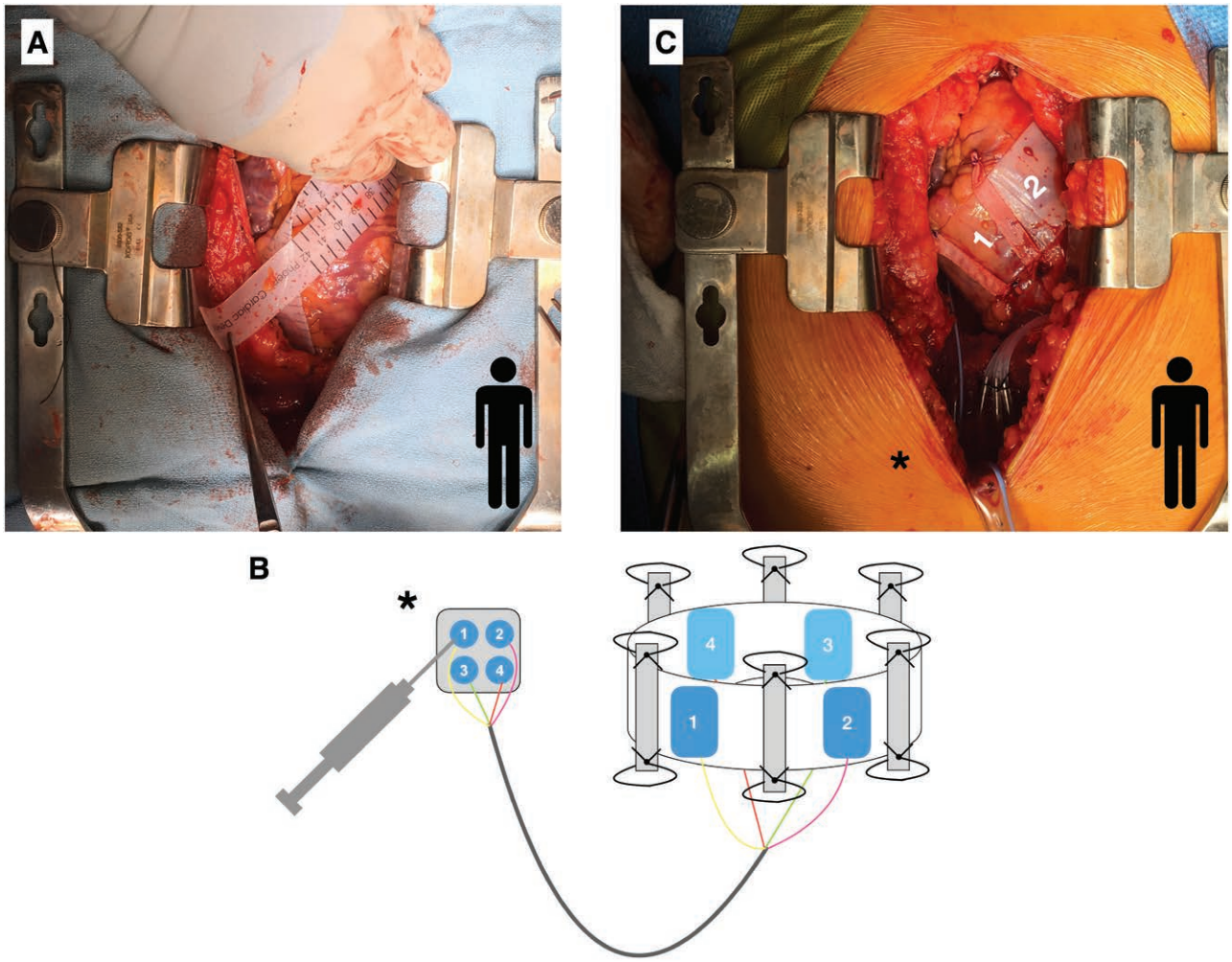

Figure 1. View of the heart (median sternotomy): (A) measuring tape positioned below the atrioventricular groove; (B) schematic diagram of BACE device: circular silicone band, inflatable chambers (1–4), silicone tubing connected to subcutaneous ports (*) corresponding to chambers (1–4); and (C) BACE in place. BACE indicates Basal Annuloplasty of Cardia Externally.

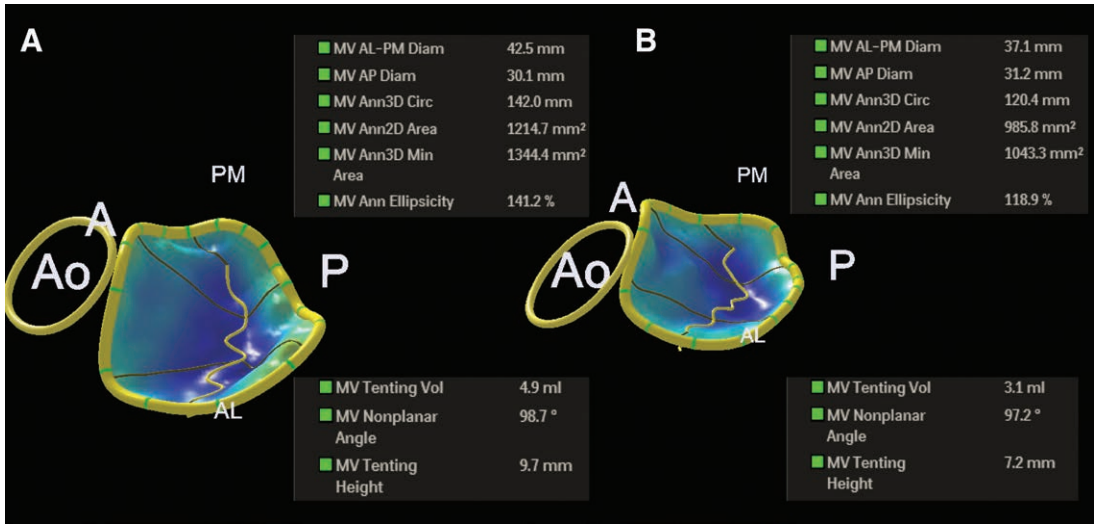

Figure 2. Three-dimensional MV reconstruction using the semiautomated Mitral Valve Navigation software (Philips) before (A) and after (B) the implantation of the BACE device. The tenting volume was reduced from 4.9 to 3.1 mL and the tenting height from 9.7 to 7.2 mm. The MV annulus area was decreased from 1215 to 986 mm^2 with a reduction of the posteromedial to anterolateral (from 42.5 to 37.1 mm) and increase in anteroposterior (30.1–31.2 mm) MV diameters. BACE indicates Basal Annuloplasty of Cardia Externally; MV, mitral valve.

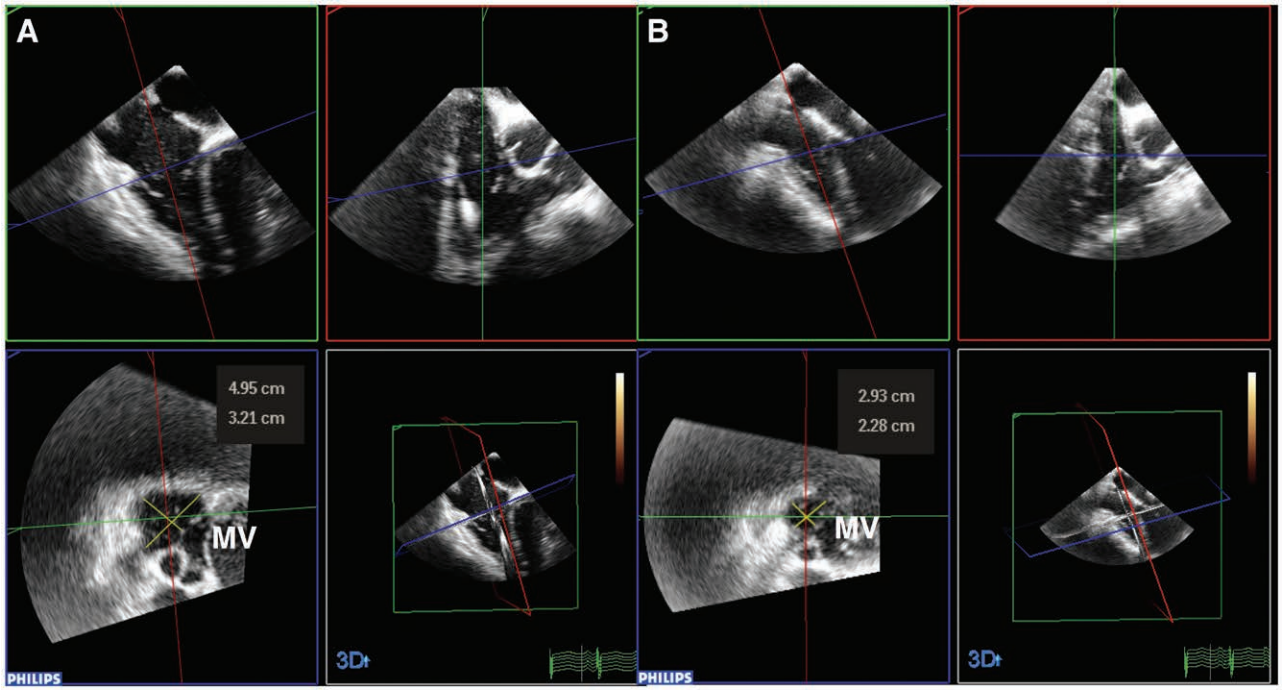

Figure 3. Multiplanar reconstruction of the tricuspid valve annulus from a 3D TEE data set acquired using full-volume ECG-gated acquisition from a modified midesophageal 4-chamber view. The blue plane was positioned to intersect the TV annulus. Maximum and minimum TV annular diameters were measured in the short-axis TV view (blue panel) before (A) and after (B) the BACE device implantation assuming a flat TV annulus. BACE, Basal Annuloplasty of Cardia Externally; TV, tricuspid valve; ECG, electrocardiography; TEE, transesophageal echocardiography; 3D, 3-dimensional.

Table. Indications and Contraindications to BACE Implant

Indications
Moderate to severe ischemic mitral regurgitation
NYHA class II to IV
Normal MV leaflets
Contraindications
Rheumatic heart disease
ANY structural mitral valve abnormality
Moderate or severe tricuspid stenosis
Severe pulmonary hypertension (systolic pulmonary artery pressure >60 mm Hg)
ST-elevation myocardial infarction within 30 d or non-ST segment elevation myocardial infarction within 7 d
Previous mitral valve surgery
Prior coronary artery bypass graft surgery
History of IV drug abuse
Chronic renal failure requiring hemodialysis

Abbreviations: BACE, Basal Annuloplasty of Cardia Externally; IV, intravenous; MV, mitral valve; NYHA, New York Heart Association.

TV valvular geometry. On 3D analysis, the MV annulus became less elliptic with a reduction in tenting volume. We also observed an incidental decrease in TV annular diameters.

Possible complications mandating chamber deflation include LV failure due to abrupt resolution of MR, iatrogenic mitral or tricuspid stenosis, and right ventricular outflow tract compression.

In our case, despite a lack of improvement of MR grade after BACE positioning, the patient NYHA status improved at 6 months postimplant without progression of ischemic MR. This may be explained by either underestimation of residual MR in the operating room or improved cardiac function due to altered interventricular coupling.

DISCLOSURES

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Contribution: This author helped create the outline, and write the manuscript.
Conflicts of Interest: None.
Name: Vivek Rao, MD, PhD.
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Contribution: This author helped conceive this review paper, create the outline, provide and edit all images and videos, and edit the manuscript.
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