Journal of Cardiothoracic and Vascular Anesthesia ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

ScienceDirect

journal homepage: www.jcvaonline.com

Original Article

Morphologic Evaluation of the Mitral Annulus During Displacement of the Heart in Off-Pump Coronary Artery Bypass Surgery

Yuki Toyama, MD[*,1], Hirotsugu Kanda, MD, PhD[*], Kotaro Igarashi, MD[†], Hajime Iwasaki, MD, PhD[*], Megumi Kanao-Kanda, MD, PhD[*], Takafumi Iida, MD, PhD[*], Takayuki Kunisawa, MD, PhD[*]

[*]*Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University, Asahikawa, Hokkaido, Japan*

[†]*Sapporo Cardio Vascular Center, Sapporo, Hokkaido, Japan*

Objective: To evaluate the morphologic changes of the mitral annulus using 3-dimensional transesophageal echocardiography during heart displacement to expose the anastomosis site in off-pump coronary artery bypass surgery (OPCAB).
Design: Prospective case series.
Setting: Single center, university hospital.
Participants: The study comprised 34 consecutive patients who underwent OPCAB of the left circumflex artery (LCX) and the right coronary artery (RCA).
Interventions: None.
Measurements and Main Results: Mitral annulus parameters were measured using the Mitral Valve Quantification program after sternotomy (physiologic position) and during displacement of the heart to expose the LCX (LCX position) and the RCA (RCA position). The height of the mitral annulus was significantly lower in the LCX (5.76 $\pm$ 0.90 mm) and RCA (5.92 $\pm$ 0.97 mm) positions than in the physiologic position (6.96 $\pm$ 0.99 mm; both $p < 0.0001$). The percent change in the height of the mitral annulus was significantly greater in the mitral regurgitation group than in the mitral regurgitation nondeterioration group when in the LCX (−16.3% $\pm$ 6.0% *v* −11.9% $\pm$ 3.3%, $p = 0.0203$) and RCA (−16.9% $\pm$ 6.3% *v* −12.1% $\pm$ 3.8%, $p = 0.0207$) positions. The anteroposterior and intercommissural diameters, annulus perimeter, and surface area of the mitral annulus did not differ significantly among all heart positions.
Conclusions: The mitral annulus flattened and lost its saddle shape without expanding while in the LCX and RCA positions. The greater percent change in the height of the mitral annulus may aggravate mitral regurgitation.

Key Words: three-dimensional transesophageal echocardiography; Mitral Valve Quantification program; mitral annulus; off-pump coronary artery bypass surgery

SINCE THE DEVELOPMENT of various surgical techniques and devices and improvements in anesthetic management, the number of off-pump coronary artery bypass (OPCAB) surgeries performed for myocardial revascularization has increased,[1–4] and OPCAB is a frequently used approach at many cardiac surgical centers. Displacement of the heart to expose the anastomosis site during OPCAB often causes hemodynamic disturbances, however, particularly during coronary artery grafting of the posterior and lateral cardiac surfaces.[5] Several potential mechanisms underlie the hemodynamic disturbances during this period, including myocardial

[1]*Address reprint requests to* Yuki Toyama, MD, Department of Anesthesiology and Critical Care Medicine, Asahikawa Medical University, Midorigaoka-higashi 2-1-1-1, Asahikawa, Hokkaido, 078-8510, Japan.

E-mail address: yukitoyama777@yahoo.co.jp (Y. Toyama).

http://dx.doi.org/10.1053/j.jvca.2017.08.023
1053-0770/

ischemia, reduced preload, cardiac dysfunction caused by compression exerted by a stabilizer, and mitral regurgitation (MR).[6,7] Existing MR may be aggravated by heart displacement during OPCAB.[8,9] Moreover, MR emerges in some patients whose preoperative cardiac evaluation showed no MR.[9,10]

Three-dimensional transesophageal echocardiography (3D TEE) allows for the evaluation of cardiac structures and complex cardiac abnormalities in mitral valve anatomy.[11,12] In contrast to 2D TEE, the birds-eye view provided by 3D TEE enables visualization of the whole mitral valve, including the leaflet, coaptation, and annulus. Moreover, the 3D TEE analyzing software, the Mitral Valve Quantification (MVQ) program, acquires quantitative parameters, including the height of the mitral annulus, the anteroposterior and intercommissural diameters, the annulus perimeter, and the surface area of the mitral annulus. Therefore, the introduction of 3D TEE and 3D TEE analyzing software into clinical practice provides a range of new possibilities for assessing mitral valve pathologies because changes in the mitral annulus shape and size during OPCAB can be observed.

The mitral annulus becomes distorted during OPCAB, which may result in worsening MR.[13,14] In addition, the height of the mitral annulus decreases and flattens in mitral valve prolapse and ischemic MR.[15,16] To the best of the authors' knowledge, no detailed assessments of the mitral annulus have been performed using 3D TEE when the heart is placed in a nonphysiologic (vertical) position during OPCAB. The aim of this study was to evaluate the morphologic changes of the mitral annulus in detail using intraoperative 3D TEE when the heart is displaced to expose the anastomosis site during OPCAB.

Methods

The institutional review board of Asahikawa Medical University approved the study protocol, and all patients provided written, informed consent. This study was registered in the University Hospital Medical Information Network under registration number UMIN000011977.

Patients undergoing OPCAB of the left circumflex artery (LCX) and the right coronary artery (RCA) were eligible for inclusion. Patients with a history of mitral valve surgery, 3+ to 4+ MR, or contraindications for TEE probe insertion were excluded. The same surgical team performed all procedures, and similar surgical techniques were used.

An arterial catheter was placed in the radial artery before induction of general anesthesia. General anesthesia was induced by a target-controlled intravenous infusion of propofol (2.0-4.0 μg/mL) and continuous infusion of remifentanil (0.1-0.5 μg/kg/min). Propofol was infused to maintain a bispectral index ranging between 40 and 60. A pulmonary artery catheter and TEE probe were inserted after induction. TEE was performed in all study participants using the 3D matrix transducer (X7-2T) with the Philips iE33 system (Philips, Amsterdam, The Netherlands). All TEE examinations were performed and concurrently interpreted by cardiac anesthesiologists who were experienced in perioperative echocardiography and had National Board of Echocardiography Advanced Perioperative Transesophageal Echocardiography certification.

After standard midline sternotomy, 3D zoom data of the mitral valve were acquired during 1 beat from the midesophageal mitral commissural view using 3D TEE with the heart in the physiologic position, which allowed for evaluation of a specific magnified part of the 3D image. Next, 3D zoom data were acquired during displacement of the heart to expose the LCX (LCX position) using a vacuum-assisted apical suction device with the Starfish heart positioner (Medtronic, Minneapolis, MN) and the Acrobat stabilizer system (Guidant, Santa Clara, CA) with the patient in the Trendelenburg position. After anastomoses of the LCX, 3D zoom data of the RCA (RCA position) were similarly obtained. During anastomoses of the LCX territory, the heart was tilted and fixed in a vertical and rightward-rotated position. Patients were maintained in the

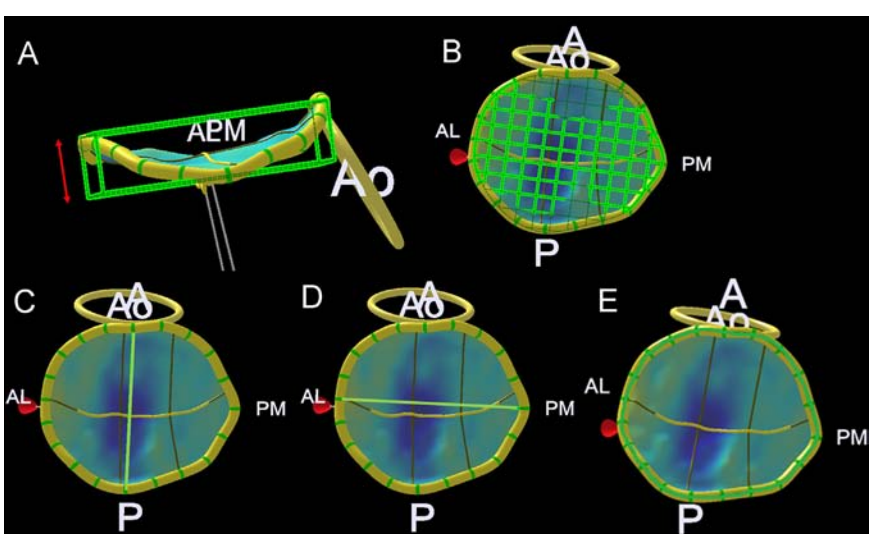

Fig 1. Parameters of the mitral annulus using the MVQ program. (A) Height of mitral annulus, (B) surface area, (C) anteroposterior diameter, (D) intercommissural diameter, (E) perimeter. AAo: A and Ao, AL: antrolateral, PM: posteromedial, A: anterior, P: posterior, Ao: aortic valve.

Please cite this article as: Toyama Y, et al. (2017), http://dx.doi.org/10.1053/j.jvca.2017.08.023