

The value of preoperative 3-dimensional over 2-dimensional valve analysis in predicting recurrent ischemic mitral regurgitation after mitral annuloplasty



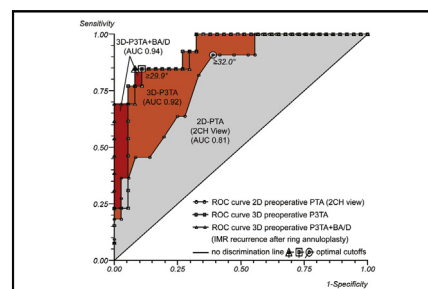
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ABSTRACT

Objectives: Repair for ischemic mitral regurgitation with undersized annuloplasty is characterized by high recurrence rates. We sought to determine the value of pre-repair 3-dimensional echocardiography over 2-dimensional echocardiography in predicting recurrence at 6 months.

Methods: Intraoperative transesophageal 2-dimensional echocardiography and 3-dimensional echocardiography were performed in 50 patients undergoing undersized annuloplasty for ischemic mitral regurgitation. Two-dimensional echocardiography annular diameter and tethering parameters were measured in the apical 2- and 4-chamber views. A customized protocol was used to assess 3-dimensional annular geometry and regional leaflet tethering. Recurrence (grade ≥ 2) was assessed with 2-dimensional transthoracic echocardiography at 6 months.

Results: Preoperative 2- and 3-dimensional annular geometry were similar in all patients with ischemic mitral regurgitation. Preoperative 2- and 3-dimensional leaflet tethering were significantly higher in patients with recurrence ($n = 13$) when compared with patients without recurrence ($n = 37$). Multivariate logistic regression revealed preoperative 2-dimensional echocardiography posterior tethering angle as an independent predictor of recurrence with an optimal cutoff value of 32.0° (area under the curve, 0.81; 95% confidence interval, 0.68-0.95; $P = .002$) and preoperative 3-dimensional echocardiography P3 tethering angle as an independent predictor of recurrence with an optimal cutoff value of 29.9° (area under the curve, 0.92; 95% confidence interval, 0.84-1.00; $P < .001$). The predictive value of the 3-dimensional geometric multivariate model can be augmented by adding basal aneurysm/dyskinesis (area under the curve, 0.94; 95% confidence interval, 0.87-1.00; $P < .001$).



Preoperative predictors of recurrent IMR 6 months after annuloplasty: 3DE versus 2DE.

Central Message

Preoperative 3DE P3TA is a stronger independent predictor of IMR recurrence 6 months after annuloplasty than preoperative 2DE PTA.

Perspective

Preoperative 3DE P3TA is a stronger predictor of IMR recurrence 6 months after annuloplasty than preoperative 2DE PTA, which is highly influenced by viewing plane selection. In patients with a preoperative P3TA of 29.9° or larger (especially when combined with the presence of a basal aneurysm/dyskinesis), chordal-sparing valve replacement should be strongly considered.

See Editorial Commentary page 860.

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Abbreviations and Acronyms

AUC	= area under the curve
CI	= confidence interval
CTSN	= Cardiothoracic Surgical Trials Network
df	= degrees of freedom
IMR	= ischemic mitral regurgitation
LV	= left ventricular
MR	= mitral regurgitation
OR	= odds ratio
P3TA	= P3 tethering angle
PTA	= posterior tethering angle
ROC	= receiver operating characteristic
TEE	= transesophageal echocardiography
3D	= 3-dimensional
2DE	= 2-dimensional echocardiography
3DE	= 3-dimensional echocardiography

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Conclusions: Preoperative 3-dimensional echocardiography P3 tethering angle is a stronger predictor of ischemic mitral regurgitation recurrence after annuloplasty than preoperative 2-dimensional echocardiography posterior tethering angle, which is highly influenced by viewing plane. In patients with a preoperative P3 tethering angle of 29.9° or larger (especially when combined with basal aneurysm/dyskinesis), chordal-sparing valve replacement should be strongly considered. (*J Thorac Cardiovasc Surg* 2016;152:847-59)

Ischemic mitral regurgitation (IMR) is common, and its presence adversely affects survival, with a strongly graded relationship between IMR severity and reduced survival.^{1,2} Mitral valve repair with undersized ring annuloplasty has been the preferred treatment strategy for IMR³⁻⁵; however, the overall persistence and recurrence rate of moderate or severe IMR within 12 months of surgery have been consistently reported to affect approximately one third of the treated patients.⁶⁻⁸ Goldstein and colleagues⁹ recently showed that the recurrence rate of moderate or severe IMR may be as high as 58.8% after a 2-year follow-up period. IMR repair failure continues to be a significant clinical problem, because IMR recurrence predisposes to heart failure, atrial fibrillation, and repeat interventions and hospitalizations.^{7,9}

With 3-dimensional echocardiography (3DE) and advanced image modeling, we have recently shown that the degree of preoperative mitral leaflet tethering determines the risk of IMR recurrence after undersized ring annuloplasty.¹⁰ Current annuloplasty rings treat annular dilatation but do little to improve (and may potentiate) leaflet tethering.^{11,12} This may explain the limited repair durability after annuloplasty (especially in patients with advanced tethering) and suggests that a patient-specific approach based on preoperative imaging is required to optimize postoperative results.

Because the results of 2-dimensional echocardiography (2DE) are highly dependent on viewing plane selection, studies reporting on preoperative 2DE predictors of IMR recurrence after annuloplasty show inconsistent, frequently nonreproducible, and sometimes conflicting results.^{6,13-34} To improve patient selection and postoperative outcome, we sought to determine the incremental value of preoperative 3DE and advanced mitral valve modeling over 2DE in predicting recurrent IMR after mitral annuloplasty. We recently published the 3DE results of 50 patients with IMR,¹⁰ and to determine the incremental value of 3DE over 2DE, we performed additional 2DE analyses in this same group of 50 patients ([Video 1](#)).

MATERIALS AND METHODS

This study was approved by the Institutional Review Boards of the University of Pennsylvania, University of Pittsburgh, and Beth Israel Deaconess Medical Center. Written informed consent was obtained from all patients.

Patients and Image Acquisition

Fifty patients with severe IMR underwent mitral valve repair with an undersized annuloplasty ring (2 sizes down) ([Table 1](#)). IMR was defined as mitral regurgitation (MR) occurring as a consequence of myocardial infarction or myocardial ischemia in the absence of any inherent structural

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VIDEO 1. The value of preoperative 3-dimensional over 2-dimensional valve analysis in predicting recurrent IMR after mitral annuloplasty. Video available at [http://www.jtcvsonline.org/article/S0022-5223\(16\)30670-5/addons](http://www.jtcvsonline.org/article/S0022-5223(16)30670-5/addons).

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