



Impact of Concomitant Tricuspid Annuloplasty on Tricuspid Regurgitation, Right Ventricular Function, and Pulmonary Artery Hypertension After Repair of Mitral Valve Prolapse

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ABSTRACT

BACKGROUND For patients undergoing mitral valve (MV) repair, the indications for and results of concomitant tricuspid annuloplasty remain controversial.

OBJECTIVES This study was designed to compare a strategy of routine concomitant tricuspid annuloplasty for moderate tricuspid regurgitation (TR) or tricuspid annular dilation in patients undergoing degenerative MV surgery.

METHODS Of 645 consecutive patients (mean age 57 ± 13 years) undergoing primary repair of degenerative mitral regurgitation between 2003 and 2011, 419 (65%) underwent concomitant tricuspid annuloplasty for moderate TR and/or tricuspid annular dilation. These patients were retrospectively analyzed with longitudinal echocardiographic follow-up.

RESULTS Patients undergoing tricuspid valve repair were older (mean age 59.2 years vs. 52.3 years), had worse right and left ventricular function and higher pulmonary artery pressures, and were more likely to have had atrial fibrillation than patients undergoing isolated MV repair (all $p < 0.05$). No significant difference in 30-day mortality, morbidity, or permanent pacemaker requirement was seen between treatment groups. Freedom from moderate TR at 7 years was not significantly different in the 2 groups, but multivariate analysis showed that tricuspid annuloplasty was independently associated with freedom from late moderate TR ($p = 0.04$), and was an independent predictor of recovery of right ventricular function ($p = 0.02$).

CONCLUSIONS In patients with moderate TR or tricuspid annular dilation who were undergoing degenerative mitral repair, concomitant tricuspid annuloplasty is safe, effective, and associated with improved long-term right-sided remodeling. Routine treatment of moderate TR or tricuspid annular dilation at the time of MV repair appears to be beneficial. (J Am Coll Cardiol 2015;65:1931-8) © 2015 by the American College of Cardiology Foundation.

For patients with less than severe tricuspid regurgitation (TR) who are undergoing mitral valve (MV) repair, the indications for concomitant tricuspid annuloplasty remain subject to debate, with the reported frequency of concomitant tricuspid valve repair ranging from more than 60% to <6% (1-4). Evidence that MV repair or replacement alone

can improve functional TR (5) has led clinicians to pursue a conservative approach to concomitant tricuspid repair (6). Advocates of a more aggressive strategy point to the following: the relatively high incidence of significant TR after isolated MV operation (2,7,8); the adverse impact of TR on long-term mortality (7,9,10), morbidity (9,11), and functional

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**ABBREVIATIONS
AND ACRONYMS****AF** = atrial fibrillation**MV** = mitral valve**PAH** = pulmonary artery
hypertension**RV** = right ventricular**TR** = tricuspid regurgitation

outcome (7); and the safety and efficacy of tricuspid annuloplasty (11-13), particularly compared with the relatively high mortality associated with reoperative surgery for isolated TR. Data on the effect of concomitant tricuspid annuloplasty on progression of TR, ventricular remodeling, and pulmonary artery hypertension (PAH) after degenerative MV repair are lacking.

The aim of this study was to evaluate the outcomes of a strategy of routine concomitant tricuspid annuloplasty for moderate TR or significant annular dilation in patients undergoing surgical treatment of a degenerative MV.

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METHODS

STUDY POPULATION. We retrospectively analyzed 646 consecutive patients with mitral regurgitation secondary to degenerative disease who underwent MV repair by a single surgeon (D.H.A.) at Mount Sinai Medical Center (New York, New York) between 2003 and 2011. One patient underwent MV replacement after repair complicated by atrioventricular groove hematoma; this patient was excluded from the analysis. All other patients underwent MV repair (99.8% repair rate). Patients with severe 3-vessel coronary artery disease, and patients who required concomitant aortic valve replacement or reoperative surgery were excluded from the analysis, to reduce the number of potential major confounders. Degenerative MV disease was defined as Carpentier type II mitral regurgitation resulting from chordal elongation or chordal rupture with excess leaflet motion. Barlow disease was defined by the presence of multisegment prolapse in a large valve; fibroelastic deficiency as the presence of single segment prolapse in a normal-sized valve; and forme fruste as valves sharing characteristics of both these etiologic factors. Connective tissue disorders were diagnosed pre-operatively on the basis of established diagnostic criteria. The research protocol was approved by the Icahn School of Medicine at Mount Sinai Institutional Review Board and was compliant with Health Insurance Portability and Accountability Act regulations and the ethical guidelines of the 1975 Declaration of Helsinki. The approval included a waiver of informed consent and a request to access data of decedents.

Indications for tricuspid valve repair were as follows: 1) the presence of moderate TR on either the pre-operative or the pre-bypass echocardiogram (whichever was the greater grade); 2) significant annular dilation assessed on pre-bypass echocardiography at end-diastolic diameter in the 4-chamber

view as an annulus >40 mm; or 3) in the case of equivocal findings, on the basis of direct assessment, intraoperative saline testing, and comparison of the anterior and posterior leaflet surface area with the annulus size (14) (Online Figure 1).

Patients undergoing tricuspid annuloplasty (65%; n = 419) received ring sizes ranging from 24 to 34; 83% of whom received a ring size of 28 or smaller. The tricuspid valve was evaluated directly via a right atriotomy for a mismatch between the leaflet surface area and the annulus size, when echocardiographic findings were equivocal and additional risk factors were present (e.g., atrial fibrillation [AF], PAH, or right ventricular [RV] dysfunction), as found in 301 patients (47%). Of this group, 221 underwent tricuspid annuloplasty. Techniques of tricuspid valve and MV repair have been previously described in detail (14). The tricuspid ring was sized according to the combined surface area of the posterior and anterior tricuspid leaflets extended using a right-angle hook and implanted with simple, interrupted mattress sutures sparing the septal annulus and conduction tissue in the region of the apex of the triangle of Koch.

DATA COLLECTION AND FOLLOW-UP. Operative mortality was defined as any death within 30 days or at any time during the same hospital stay. Post-operative morbidity was defined as stroke, new-onset renal failure, ventilation or reintubation for >72 h, new requirement for permanent pacemaker, surgical re-exploration, and deep sternal wound infection or sepsis. Pre-operative RV function was assessed qualitatively, mainly on the basis of wall motion abnormality and ventricular dilation by echocardiography pre-operatively or, if that was not available, by pre-bypass transesophageal echocardiography. Mitral regurgitation and TR were graded according to guideline-recommended standard quantitative and semiquantitative methods as none, mild, moderate, or severe (15). Pre-operative and pre-discharge echocardiography was obtained for all patients, of whom 85% (n = 535) also had post-discharge echocardiography available. A total of 1,432 echocardiograms were included in the analysis. Mean follow-up was 3.7 years (range 0.1 to 8.4 years). The earliest echocardiogram on which moderate or greater TR was indicated for each patient was used to designate recurrent TR. Post-operative RV function was defined as normal or decreased on the basis of the latest report available for each patient; mild, moderate, or severe dysfunction was grouped as decreased RV function. Survival data were obtained for all patients; for documented U.S. patients, this occurred by cross matching each patient's Social Security number with the Web-based Social Security death index.

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