



Tricuspid regurgitation is uncommon after mitral valve repair for degenerative diseases

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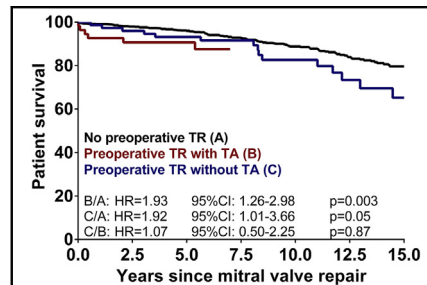
ABSTRACT

Objective: To determine the incidence and effects of tricuspid regurgitation (TR) after surgery for mitral valve (MV) repair for mitral regurgitation (MR) due to degenerative disease.

Patients and Methods: We examined 1171 patients who had MV repair and were followed prospectively with periodical clinical and echocardiographic assessments during a mean of 9.1 ± 5.3 years. Patients' mean age was 58.2 ± 12.7 years, and 70.5% were men. Preoperatively, 44.6% were in functional classes III and IV, 20.1% had atrial fibrillation, and 34.2% had ejection fraction $<60\%$. In addition to MV repair, 13.8% had coronary artery bypass, 11.4% had the maze procedure, and 4.7% had tricuspid annuloplasty.

Results: Moderate and severe TR was present in 138 patients before surgery and associated with older age, preoperative atrial fibrillation, preoperative congestive heart failure, congenital heart septal defects, lower preoperative left ventricular ejection fraction, and female sex by multivariable analysis. TR resolved postoperatively but recurrent or new isolated TR occurred in 45 patients postoperatively (13.6% at 15 years in all patients). Factors associated with isolated postoperative TR by multivariable analysis included older age at operation, unrepaired preoperative moderate/severe TR, and the development of postoperative MR. Patients with preoperative TR had reduced long-term survival and tricuspid annuloplasty did not restore lifespan.

Conclusions: Preoperative TR in patients with MR due to degenerative diseases was associated with longstanding MV disease and adversely affected long-term survival after MV repair. New postoperative TR was uncommon. The findings of this study are compelling reasons to repair the MV before the development of TR. (*J Thorac Cardiovasc Surg* 2017;154:110-22)



Patients' survival after mitral valve repair.

Central Message

Functional tricuspid regurgitation after mitral valve repair for degenerative diseases of the mitral valve was uncommon in this long-term study.

Perspective

Functional tricuspid regurgitation in patients with mitral regurgitation due to degenerative diseases was associated with older age, chronic atrial fibrillation, advanced functional class, congenital heart defects, impaired left ventricular function, and female sex. These factors adversely affected long-term survival after valve repair and concomitant tricuspid annuloplasty did not restore lifespan.

See Editorial Commentaries pages 123 and 125.

See Editorial page 108.

This study was prompted by a presentation by Joanna Chikwe at the 2015 Annual Meeting of The American Association for Thoracic Surgery (AATS) in Seattle, where she reported on a series of 645 patients who had mitral valve (MV) repair for degenerative disease and 419 (65%) of

them had concomitant tricuspid annuloplasty (TA) because of moderate tricuspid regurgitation (TR), tricuspid annular diameter ≥ 40 mm by echocardiography, or direct inspection of the tricuspid valve (TV) in equivocal cases.¹ Because 83% of the patients who TA had mild, trace, or no TR, the mean diameter of the tricuspid annulus was 38.8 mm, and more than one half of all patients had advanced myxomatous degeneration of the MV (which often involves the TV too), we argued that the rate of TA

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Abbreviations and Acronyms

AATS	= American Association for Thoracic Surgery
AF	= atrial fibrillation
CI	= confidence interval
HR	= heart ratio
MR	= mitral regurgitation
MV	= mitral valve
OR	= odds ratio
TA	= tricuspid annuloplasty
TR	= tricuspid regurgitation
TV	= tricuspid valve

was excessively high and unnecessary. Robert Dion clearly disagreed with our views and gave the indications when TA should be combined with MV surgery in a recent editorial.² A brief review of our data confirmed our views expressed at the AATS meeting.³ In another editorial in the *Journal*, Richard Shemin put things in perspective and correctly stated that we need more evidence and less personal opinions on issues as perplexing as functional TR.⁴

This study examined the incidence of TR and its consequences in a large cohort of patients who had MV repair for mitral regurgitation (MR) due to degenerative diseases during the last 3 decades. When we first began a program of MV repair for MR in mid-1980s, we overlooked the TV unless the right side of the heart was dilated grossly at surgery or the patient had had evidence of right-side heart failure preoperatively because we believed that the TR would resolve after correction of the left-side lesion. Moreover, in reviewing the echocardiographic reports from studies done in the 1980s and 1990s, we found that the TV also was overlooked frequently by the echocardiographers because their written reports contained no information on the functional status of this valve or simply stated that the right-sided valves were normal without quantification of TR. We observed, however, that a few patients developed transient right-side failure during the first weeks after MV repair and that these patients often had echocardiographic evidence of moderate or severe TR before surgery; as a result, we increased the rate of TAs we performed over time.

PATIENTS AND METHODS

Isolated MV repair for MR due to degenerative diseases of the MV was performed in 1171 patients by one surgeon from 1985 to 2010. The clinical outcomes of MV repair on these patients were published recently in 2 separate reports, but the issue of concomitant TR was not addressed.^{5,6} We used the database from those 2 reports to design this study. Our patients were followed by the referring cardiologists, and both patients and cardiologists were contacted by our research personnel periodically (yearly during the first 2-3 years and approximately every 2-3 years thereafter), and an echocardiogram was requested to assess MV and ventricular function.

The echocardiograms were read by various cardiologists, who sent us a written report. Valve regurgitation was recorded as none, trivial, mild,

moderate, and severe (if a report read “mild to moderate,” it was counted as moderate and if read “moderate to severe,” it was counted as “severe”) and entered in a dedicated database. Most echocardiographic reports from 1980s and early 1990s had detailed information on the aortic and MVs but scant information on TV, and sometimes read “normal right-side valves.” In 119 patients who had no preoperative echocardiographic data on the TV, we used the TR grading obtained in the operating room (transepical echocardiography in the first couple of years of the study and transesophageal since 1988). Postoperative studies that reported the TV as “normal” but contained no information of the severity TR were excluded from analysis. Since the publication of the guidelines by American Society of Echocardiography in 2003, all reports contained detailed information on all 4 heart valves.⁷ The diameter of the tricuspid annulus was only sporadically measured and not entered in the datasets.

Adverse events were reported according to the guidelines set by cardiac surgical societies.⁸ The cause of death was determined by hospital chart review, death certificates, or information from the physician who was caring for the patient at that time. Clinical follow-up was complete in 98.1% (defined as patient having a terminal event or being contacted within 2 years from our previous reports on MV repair^{5,6}). Echocardiography was performed in all patients in the operating room and before discharge from hospital. Echocardiographic data were available in 95.7% of patients alive at the last follow-up. The overall mean follow-up was 9.1 ± 5.3 years, but it was shorter at 6.9 ± 4.9 years for patients who had TA combined with MV repair for the aforementioned reasons. Twelve patients with TR had leaflet prolapse and were included in the group as functional TR. This study was approved by the Review Ethics Board of the University Health Network and patients' consent waived.

Statistical Analysis

Data are presented as means with standard deviation, median with interquartile range (25th and 75th percentile), and frequencies as appropriate. Comparisons of patients' clinical profile and perioperative outcomes (Tables 1 and 2) were performed by either the Fisher exact test, Wilcoxon 2-sample test, or Student *t* test assuming unequal variance between groups, as appropriate. Visual inspection of the distribution for continuous variables was used to assess normality. Factors associated with preoperative moderate/severe TR and undergoing concomitant TA were modeled with a logistic regression models (see below for model building strategy). Recognizing that patients included in this study were at risk of multiple postoperative outcomes at the same time, a nonparametric competing risk model was developed. In this model, patients could transition to 1 of 5 possible endpoints, whichever occurred first. These endpoints are listed to follow, with the remaining of the patients being alive and free from reoperation or moderate/severe MR or TR:

- reoperation for isolated MR;
- reoperation for isolated TR;
- reoperation for concomitant MR/TR;
- reoperation for reasons other than MR or TR; or
- death before reoperation.

Cox proportional hazard was used to identify factors associated with postoperative mortality. For both the binary and time-dependent outcomes, the strategy for model building was similar. For the first time, outcome-specific univariable regression models were used to screen potential risk factors (Table E1), and risk factors with univariable *P* values $<.20$ were then included in a bootstrap resampling algorithm (1000 random resamples). Variables with a high reliability (ie, selection in $>50\%$ of the samples) were then included in a multivariable regression models with backward selection of variables to obtain a final model. TR over time was modeled with the use of longitudinal mixed models, with backward selection of variables that were statistically significant at the univariable level to obtain a final model. Mean imputation was used for

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