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Current outcomes of tricuspid valve surgery

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ABSTRACT

Surgical treatment of isolated and concomitant tricuspid disease remains underutilized. The gap between guidelines and clinical practice is reflective in large measure of the historically poor outcomes of tricuspid valve surgery. We reviewed our current surgical outcomes of tricuspid regurgitation to determine whether surgical outcomes have improved in the modern era.

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Introduction

It is estimated that tricuspid valve (TV) regurgitation (TR) affects >1.6 million people in the United States and is known to be associated with poor prognosis.[1] Functional or secondary etiology is the most common cause of TR and occurs as a consequence of right ventricular (RV) or tricuspid annular dilation causing lack of coaptation of the intrinsically normal valve leaflets.[2] Because most of the patients with significant TR have left-sided heart disease, surgical correction of the primary left-sided disorder and conservative nonsurgical strategies of the TV have been historically recommended.[3] However, untreated TR can be severe and associated with significant morbidity and mortality.[4] Despite the guideline recommendations, surgical repair of the TV remains underutilized. The gap between guidelines and clinical practice is in large measure reflective of the historically poor outcomes of TV surgery. We reviewed the current literature to determine whether these traditionally poor outcomes persist in the modern era.

Concomitant TV surgery

Functional or secondary TV disease in the setting of left heart failure (HF) is the most common cause of TV disease.[5] Left untreated, TR can cause significant clinical symptoms and right ventricular HF, which

Abbreviations: COR, Class of Recommendation; LOE, Level of Evidence; MV, Mitral valve; RV, Right ventricle or ventricular; TR, Tricuspid regurgitation; TV, Tricuspid valve; TVRR, Tricuspid valve repair or replacement.

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can manifest as not only right-sided HF symptoms but also coexisting left-sided HF symptoms.[6] Addressing the left-sided heart disease with mitral valve (MV) surgery while managing the TV disease conservatively has been the most common strategy. However, an increasing body of evidence suggests that secondary TR does not always improve after MV surgery.[6] Therefore, concomitant TV repair at the time of MV surgery is increasingly essential to patient survival and improved long-term right-sided remodeling.[6,7] The 2014 American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for the Management of Patients with Valvular Heart Disease provides a Class of Recommendation (COR) I Level of Evidence (LOE) C for TV repair in patients with severe secondary TR undergoing left-sided valve surgery. It also provides COR IIa LOE B for patients with mild, moderate, or greater TR at the time of left-sided valve surgery with either tricuspid annular dilation (>40 mm) or prior evidence of right HF.[8] The utility of concomitant TV intervention at the time of MV repair for degenerative disease is the subject of an ongoing Cardiothoracic Surgical Network trial. In this trial, 400 patients with degenerative MV disease and mild to moderate TR were randomized to MV surgery alone or MV surgery with concomitant TV annuloplasty. The results are expected in the next few years.

In a series of 645 consecutive patients undergoing MV repair, Chikwe et al.[7] reported that among the 419 (65%) who underwent concomitant TV repair, there was less TR and better right ventricular remodeling. Overall, operative mortality was 0.6%. Tricuspid annuloplasty was not found to be associated with significantly increased operative mortality or morbidity in univariate analysis ($p = .49$) or multivariate analysis ($p = .6$). Badhwar et al.[9] examined 88,473 patients who underwent MV surgery from the Society of Thoracic Surgeons database. Overall, TV repair was performed in 14.3% of all patients. After multivariable risk-adjustment, concomitant TV repair was not associated with an overall incremental mortality risk for either isolated MV repair or replacement (MVRR) or MVRR plus coronary artery bypass grafting (OR 0.99 and 1.04, respectively). Across all degrees of TR, there was no significant association between concomitant TV repair and increased mortality. Dreyfus et al. similarly found that performing concomitant TV repair not only did not increase operative mortality but also was associated with significantly improved symptoms.[10] In patients undergoing concomitant MV and TV repair, In-hospital mortality was 0.7%, and Kaplan-Meier survival rates were 98.5%, 98.5%, and 90.3% at 3, 5, and 10 years, respectively.

Recently, Brescia and colleagues[11] examined the morbidity and mortality following guideline-directed concomitant TV repair in patients undergoing MV surgery for degenerative mitral regurgitation and/or aortic valve surgery. In this study, patients with less than moderate preoperative TR (37%) were included in the analysis to adhere to the guideline recommendation for tricuspid annuloplasty in an annulus ≥40 mm. They reported an operative mortality of 0.6% and freedom from moderate or worse TR was 89% at 3 years. Given these findings, the authors confirmed that adherence to the current guideline recommendations is encouraged. Still, further longitudinal studies with echocardiographic assessment of the TV are needed. Table 1 summarizes the reported short term and long-term survival.

Table 1
Outcomes of concomitant TV surgery.

Study	Sample size	30-day mortality	Survival
Dreyfus et al., 2005	$n = 148$	0.7%	98.5% at 5 years
Chikwe et al., 2015	$n = 419$	0.6%	91 ± 5% at 7 years
Badhwar et al., 2017	$n = 12{,}623$	4.9%	
Brescia et al., 2019	$n = 171$	0.6%	92 ± 5% at 5 years

Isolated TV surgery

Isolated TR occurs in the absence of significant left-sided heart disease or pulmonary hypertension. Primary causes include infective endocarditis, leaflet injury from implanted devices, long-standing atrial fibrillation, and carcinoid and congenital TV pathologies.[5] Secondary TR may emerge in the context of annular dilation or RV dysfunction.[2] Surgical management of isolated TV disease remains relatively infrequent due to significant patient comorbidities and historically poor surgical outcomes.[12,13] The patients may be asymptomatic for prolonged periods, and thus surgical interventions are reserved for advance stages of TV disease. Therefore, clinical practice guideline recommendations are based on expert opinion and limited data because of the lack of high quality randomized controlled trials.[8,14] The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for the Management of Patients with Valvular Heart Disease provides a COR IIa LOE C recommendation for isolated TV surgery in primary TR patients who are unresponsive to medical management. In asymptomatic patients with severe primary TR who have RV dilation or dysfunction, a COR IIb, LOE C for isolated TV surgery is recommended.[8]

The decision to perform isolated valve surgery remains challenging due to limited data available to guide preoperative assessments and the lack of pre-procedural optimization strategies. In 2013, the Society of Thoracic Surgeons database analysis of >50,000 patients who underwent TV surgery from 2000 to 2010 reports that only 14.3% underwent isolated TV interventions, an average of 707 operations per year.[12]

Surgical outcomes of isolated TV disease have been reported infrequently and are mainly from single-center experiences. In a series of 50 to 69 patients, Park et al.[15] and Guenther et al.[16] reported an overall operative mortality of 10.1% and 16%, respectively. In Auckland, Oh et al.[17] reported an overall mortality rate of 12.5%, with a mortality rate of 7.9% for repair vs. 17.6% for replacement. Similar single-center experience by Raikhelkar et al.[18] reported an early mortality of 14.2% in a series of 56 patients with a mortality rate of 13.8% vs. 14.8% for repair and replacement respectively.

Zack et al.[13] reported 5005 isolated TV operations from the National Inpatient Sample Database. They were performed between 2004 and 2014, with an overall operative mortality of 8.8%. Trend analysis revealed significant changes in patient characteristics over time, including increased age and an increasing burden of comorbidities. However, unadjusted and risk-adjusted operative mortality significantly decreased during the study period. The trend toward decreased mortality was confirmed in multiple recent experiences. Ejiofor et al.,[19] in a series of 57 isolated TV operations from 2002 to 2014, reported an overall operative mortality of 8.8%. Furthermore, Hamandi et al.[20] recently demonstrated in a series of 95 patients that isolated TV surgery could be performed with a low operative mortality of 3.2%. The series spans a decade of experience, and there was no mortality in their most recent 73 patients over the last six years. In the current era with careful patient selection and periprocedural management, isolated TV surgery can be performed with lower morbidity and mortality than has traditionally been reported with good long-term survival. Table 2 summarizes the reported

Table 2
Outcomes of isolated TV surgery.

Study	Sample size	30-day mortality	Survival
Guenther et al., 2008	$n = 50$	16%	56.6 ± 8.7% at 6 years
Park et al., 2011	$n = 69$	10.1%	85.5% at 3 years
Raikhelkar et al., 2012	$n = 56$	7.1%	60% at 5 years
Oh et al., 2013	$n = 72$	12.5%	70.8% at 5 years
Ejiofor et al., 2017	$n = 57$	8.8%	82.5% at 5 years
Zack et al., 2017	$n = 5005$	8.8% (In-Hospital)	
Hamandi et al., 2019	$n = 95$	3.2%	74% at 5 years

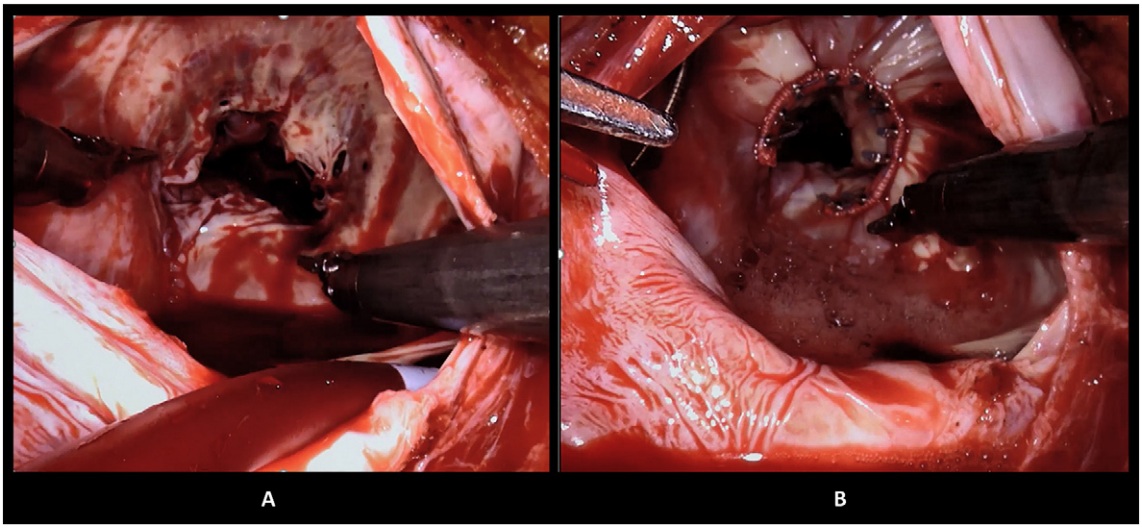

Fig. 1. Intraoperative images of robotic-assisted tricuspid valve repair before (A) and after annuloplasty (B).

short term and long-term survival. Fig. 1 shows a TV before (A) and after (B) tricuspid annuloplasty.

In general, studies have shown an inverse relationship between TR severity and survival. Nath et al.[21] demonstrated that moderate or severe TR was associated with worse prognosis compared to mild TR even in the absence of RV dysfunction or pulmonary hypertension. However, with the absence of randomized controlled trials, it is still not clear whether surgical management of isolated TR is independently associated with improved survival when compared to medical management.[22] Lee et al.[23] studied 870 consecutive patients with significant isolated TR and found that in 57 patients who underwent TV surgery, long-term survival tended to be higher by propensity-score matching compared to those who were managed conservatively. However, this did not reach a statistical significance ($p = .068$).

Recently, Axtell et al.[24] identified 3276 patients with isolated severe TR from a single-center database over a 15-year time period. Isolated TV surgery was performed in 5% at the discretion of the treating surgeon. The analysis of the entire cohort, adjusted for time from diagnosis to TV surgery in order to reduce immortal time bias, showed that TV surgery had higher survival benefit compared with medical therapy. However, when the same analysis was applied to the propensity-matched subgroup, no difference between the groups was observed. The investigators acknowledged several limitations inherent to this observational study. The timing of the surgery was not uniform, which is likely due to the lack of data supporting the indication for surgery or treatment selection bias.

Evaluation of RV function and patient selection

Careful preoperative assessment and pre−/post-procedural management is crucial for patients being considered for TV surgery. Patients with fixed pulmonary hypertension and/or advanced degrees of RV dilatation and dysfunction are unlikely to benefit from TV surgery and are likely to have increased mortality and morbidity. The evaluation of patients with functional TR who are considered for surgery should include a detailed echocardiographic examination to evaluate tricuspid annulus size, reasons for lack of leaflet coaptation, the extent of leaflet tethering, and right atrial size in addition to the severity of TR.[25] Assessment of TV function is critical using multiple parameters to evaluate RV ejection fraction and degree of dilation including RV size and ejection fraction. Detailed assessment of quantitative RV function is key including measurement of tricuspid annular plane systolic excursion, fractional area change, and most importantly free wall global longitudinal strain. These lend important data points for determining the ability of the RV to both tolerate the procedure and recover after, though no single measure seems to adequately or consistently quantify RV dysfunction. Optimizing right ventricular function can transform debilitated patients with prohibitive RV dysfunction into better surgical candidates and improve periprocedural management and outcomes.[20]

Conclusions

Surgical outcomes of TV disease have been associated with decreased perioperative mortality, morbidity, and improved survival in the current era mainly due to careful patient selection and preoperative optimization of the patient's underlying condition. Comparatively, untreated TV disease has been associated with significant long-term morbidity and mortality. Thus, current guidelines recommending non-surgical or expectant management of TV disease may be outdated. These findings should inform the field of transcatheter approaches to TR.

Declaration of competing interest

The authors report no conflict of interest with regard to this publication.

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