Minimally invasive tricuspid valve surgery in patients at high risk

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Objective: Reports of minimally invasive tricuspid valve operations are rare, and results are often contradictory. This study analyzes our 5-year experience with minimally invasive tricuspid valve operations in high-risk patients.

Methods: Between November 2005 and December 2011, tricuspid valve surgery using a nonsternotomy minimally invasive technique was performed in 64 patients (19 male, 45 female; mean age, 63.2 ± 12.8 years). Mean preoperative European System for Cardiac Operative Risk Evaluation was 7.3 ± 2.9, and predicted mortality was 11.6% ± 11.7%. Tricuspid valve regurgitation cause was functional in 36 patients (56.2%), endocarditis in 2 patients (3.1%), and rheumatic in 24 patients (37.5%). Two patients (3.1%) showed prosthesis dysfunction. Forty patients (62.5%) had undergone previous cardiac surgery.

Results: Tricuspid valve repair was performed in 35 patients (54.7%). Tricuspid valve replacement with bioprosthesis was performed in 27 patients (42.2%), and the remaining 2 patients (3.1%) underwent bioprosthetic replacement. Concomitant procedures (48) included mitral valve surgery (42 patients), atrial septal defect closure (5 patients), and myxoma exeresis (1 patient). Conversion to sternotomy occurred in 1 patient (1.6%). Overall hospital mortality was 7.9%. Stroke occurred in 1 patient (1.6%), and 5 patients underwent reoperation for bleeding (7.8%). Mean follow-up time was 21 ± 16 months (range, 1-59 months) and 100% completed. Cumulative Kaplan–Meier estimated 5-year survival was 81.3%, and 5-year freedom from reoperation was 100%.

Conclusions: The heart-port–based minimally invasive approach seems to be safe, feasible, and reproducible in case of tricuspid valve operations. It ensures low perioperative morbidity, moderate to low rates of tricuspid regurgitation recurrence, and low late mortality. It also seems to have an added value in case of reoperative procedures. (J Thorac Cardiovasc Surg 2014;147:996-1001)

Right-sided cardiac valvular disease has traditionally been considered less clinically important than mitral or aortic valve pathology, and its optimal management remains controversial. Patients are rarely referred for isolated surgical tricuspid valve (TV) repair or replacement, and most procedures are done in the context of other planned cardiac surgery.

However, significant tricuspid regurgitation (TR) can lead to functional impairment and has an adverse impact on perioperative outcomes, functional class, and survival.[1] Approximately 90% of cases of TR are secondary to left heart pathology with various degrees of pulmonary hypertension, and approximately 10% are due to primary TV disease.[2] TR is generally well tolerated; however, in the presence of pulmonary hypertension, cardiac output declines and right heart failure worsens.

Although TR leads to a dismal prognosis after symptom development and in-hospital mortality and actuarial survival are improved in patients undergoing TV annuloplasty at the time of mitral valve (MV) surgery, TR remains frequently undertreated.

Because TR can vary according to the preload, afterload, and right ventricular function,[3-5] the assessments of leaflet morphology, annular dimension (from the middle part of the septal annulus to the middle part of the anterior annulus), and pulmonary artery pressure are particularly important for determining subsequent management. It has been suggested that a tricuspid annulus diameter greater than 40 mm or 21 mm/m^2 measured in the 4-chamber view should indicate the need for TV repair[6] and that TV repair should be accomplished in patients with preoperative atrial fibrillation (AF).

Management guidelines indicate a move toward more aggressive treatment of TR.[7] For patients undergoing left-side valve surgery, TV repair or replacement is universally recommended in the presence of severe TR or tricuspid annular dilatation because it does not resolve spontaneously after correction of MV disease as once believed.[1,8,9] In those

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Abbreviations and Acronyms
AF = atrial fibrillation
ASD = atrial septal defect
MV = mitral valve
NYHA = New York Heart Association
TR = tricuspid regurgitation
TV = tricuspid valve

with isolated severe TR, surgery is recommended in the presence of symptoms or progressive right ventricular dilatation or dysfunction.[2,3,5,7,8,10-12]

Because reoperation for recurrent isolated TR carries high mortality rates (up to 37%), TV surgery is not routinely offered to many patients.[11,13] As minimally invasive approaches for treatment of aortic and MV disease are developing, parallel alternative approaches for TR may be necessary, especially for those patients with high surgical risk.

Since 2005 we have performed TV operations, isolated or in association with other procedures, through a right mini-thoracotomy using the heart-port platform as the procedure of choice. In this report, early and long-term results of this approach in high-risk patients are examined.

MATERIALS AND METHODS

Between November 2005 and December 2011 at the University of Turin, 64 patients (19 male, 45 female; mean age, 63.2 ± 12.8 years) underwent TV surgery through a lateral right mini-thoracotomy using a non-sternotomy minimally invasive technique. During the same study period, 294 patients underwent TV procedures (combined or isolated) through a standard median sternotomy. The number of TV surgeries in median sternotomy progressively and significantly decreased. For the past 2 years, all isolated TV operations have been performed with a minimally invasive approach, and combined procedures with the same technique significantly increased in the study period (data not shown). Data from all patients were retrospectively reviewed. Preoperative clinical and echocardiographic characteristics are listed in Table 1. Mean preoperative additive European System for Cardiac Operative Risk Evaluation was 7.3 ± 2.9, and logistic European System for Cardiac Operative Risk Evaluation was 11.6% ± 11.7%. Predicted mortality of patients undergoing isolated TV surgeries (16 patients) and patients undergoing concomitant mitral procedures (48 patients) was 9.01% ± 2.25% and 12.52% ± 13.02%, respectively ($P < .05$). Mean New York Heart Association (NYHA) functional class was 2.8 ± 0.9 (median, 3; range, 1-4). More than 50% of patients (37/64) were in NYHA class III or IV. AF was present in 43 patients (67.2%). Mean preoperative degree of TR was 3.3 ± 1.1 (median, 4; range, 3-4). Mean left ventricular ejection fraction was 58.7% ± 3.5%. Pulmonary hypertension (defined as systolic pulmonary artery pressure ≥60 mm Hg) was measured in 27 patients (42.2%).

TR severity was based on the absolute size of the regurgitant jet by color flow imaging, the relative size of the regurgitant jet (relative to the right atrium area), and the hepatic venous flow pattern, as recommended by the guidelines of the American Society of Echocardiography.[14,15] In addition, tricuspid annulus diameter was measured in the 4-chamber view to confirm the need for TV repair. In our series, mean TV annulus diameter, measured by echocardiography, was 45.5 ± 7.2 mm.

TV regurgitation cause was functional in 36 patients (56.3%), due to endocarditis in 2 patients (3.1%), and due to rheumatic disease in 24 patients (37.5%). Two patients (3.1%) showed prosthesis dysfunction.

Forty patients (62.5%) underwent reoperations, 8 (20.0%) of whom had undergone 2 previous cardiac surgeries and 12 (30.0%) of whom had undergone 3 or more previous operations; all were valve surgeries, with no previous CABG. In 12 patients (30.0%), it was a previous TV procedure: 2 TV replacements, 1 TV exeresis for endocarditis, and 9 TV repairs (2 Kay procedures and 7 De Vega procedures).

Isolated TV regurgitation was present in 16 patients (25.0%). One of these patients had prosthesis valve deterioration. Concomitant cardiac diseases were diagnosed in the remaining 48 patients (75.0%). A total of 42 patients (65.6%) had concomitant severe mitral regurgitation (native MV regurgitations in 28, prosthesis valve deterioration in 9, and mechanical prosthesis dysfunction in 5). Five patients (7.8%) had a concomitant patent foramen ovale or an atrial septal defect (ASD), and 1 patient had a left atrial myxoma (1.5%).

All patients were screened preoperatively for adequate vascular access by an additional aorto-iliac and femoral artery angiography at the time of cardiac catheterization or by angio-computed tomography scan. Arterial cannulation was obtained through the femoral artery with an Endo-return cannula (EndoReturn arterial cannula 21F or 23F; Edwards Lifesciences, Irvine, Calif) in 43 patients (67.2%) and a standard femoral cannula in 16 patients (15.6%). In 5 patients (7.8%), direct transthoracic aortic cannulation was obtained with the EndoDirect cannula (EndoDirect arterial cannula 24F; Edwards Lifesciences). In case of cannulation with the EndoReturn and EndoDirect systems, aortic clamping was obtained with endoaortic balloons (EndoClamp aortic catheter, Edwards Lifesciences). In case of standard femoral artery cannulation, a Chitwood transthoracic clamp (Scanlan International, St. Paul, Minn) was used. The decision on the type of clamping to use (EndoReturn clamp, EndoDirect clamp, Chitwood clamp) was based on the anatomy of the sinotubular junction, the aorto-iliac-femoral anatomy, the chest structure, and history of cardiothoracic procedures. For example, in case of tortuous and atheromatous aorto-iliac-femoral anatomy, an endovascular clamping technique with the EndoDirect kit was preferred; in case of previous cardiac procedures with a normal vascular anatomy, a peripheral endovascular approach (EndoReturn) was predominantly; in case of a dilated ascending aorta (diameter >38-40 mm), a Chitwood transthoracic clamp was predominantly used. The selection of clamps was patient oriented and independent of the learning curve.

Venous return was routinely obtained with a double cannulation (jugular and femoral). Jugular cannulation was always achieved percutaneously using a 17F or 21F Medtronic (Minneapolis, Minn) cannula or a 18F or 20F Edwards Lifesciences cannula (OptiSite). Femoral cannulation was performed percutaneously in all cases of simultaneous EndoDirect aortic cannulation. In case of EndoReturn or standard femoral artery cannulation, a minimal (3 cm) groin incision was necessary, and both arterial and femoral cannulations were directly performed using the Seldinger technique through two 4/0 Prolene purse strings. Femoral vein cannulation was obtained with QuickDraw venous cannulas (Edwards Lifesciences). The technique of direct aortic cannulation with the EndoDirect system has been described by Glower and colleagues.[16,17] The port access surgical technique used at the University of Turin has been described.[18] Before opening the right atrium, the superior and inferior venae cavae were occluded. Snaring was obtained by placing tourniquets around the superior and inferior venae cavae in 56 patients (87.5%) or placing endovascular balloons (7F, 65 cm; Boston Scientific, Natick, Mass) in 8 patients (12.5%). The endovascular balloons are delivered under transesophageal echocardiography into the right atrium from the right femoral vein (through a 7F introducer) and from the right jugular vein (through a Y-modified cannula). This last approach was preferred in case of previous cardiac surgeries to avoid dangerous dissections. In case of concomitant operation (MV or myxoma), the left atrium was accessed first. After completing the left-sided operation, the left atrium was closed and complete de-airing was