
Repair of Tricuspid Regurgitation: The Posterior Annuloplasty Technique

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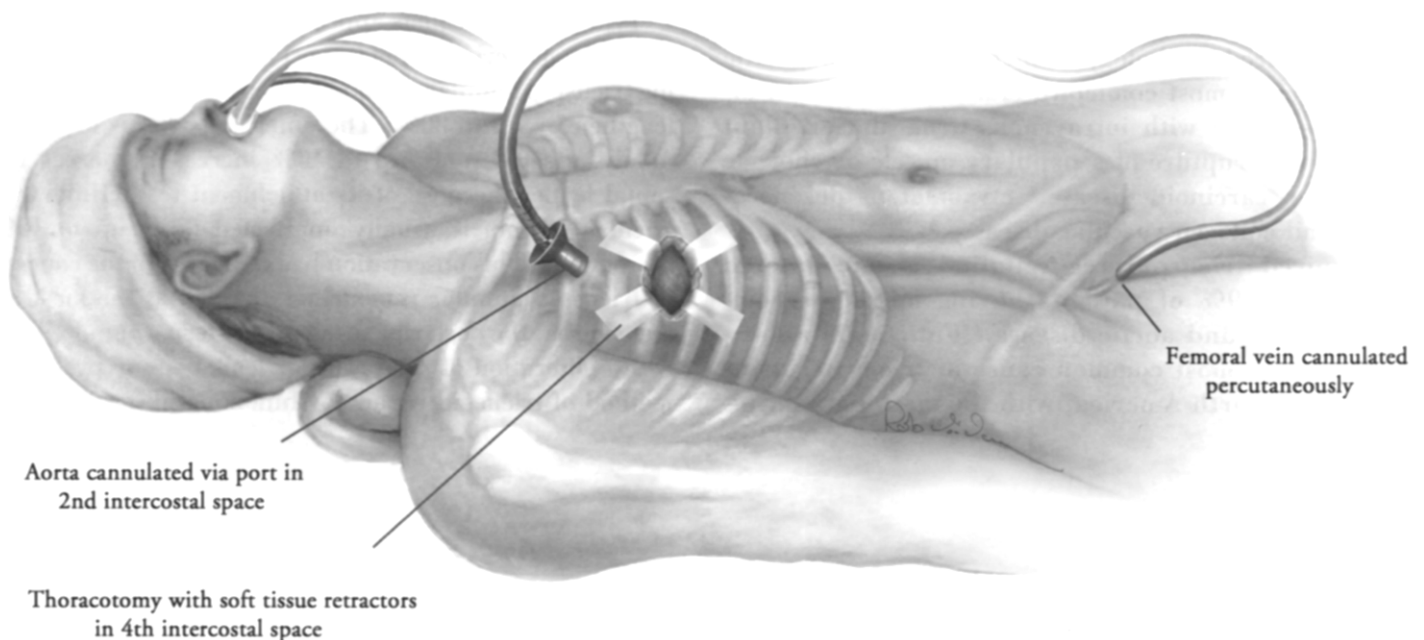
Tricuspid regurgitation is caused by structural or functional etiologies. Structural tricuspid insufficiency results from either congenital heart disease or from acquired pathology, which includes rheumatic heart disease (most common), endocarditis (almost always associated with intravenous drug abuse), blunt trauma with rupture of a papillary muscle or chordae tendineae, carcinoid disease,¹ myxomatous degeneration,² and collagen-vascular diseases.³

Acquired tricuspid regurgitation is encountered in 22% to 59% of patients having mitral or combined mitral and aortic disease.⁴ Functional abnormality is the most common cause of tricuspid insufficiency in North America, with the main pathophys-

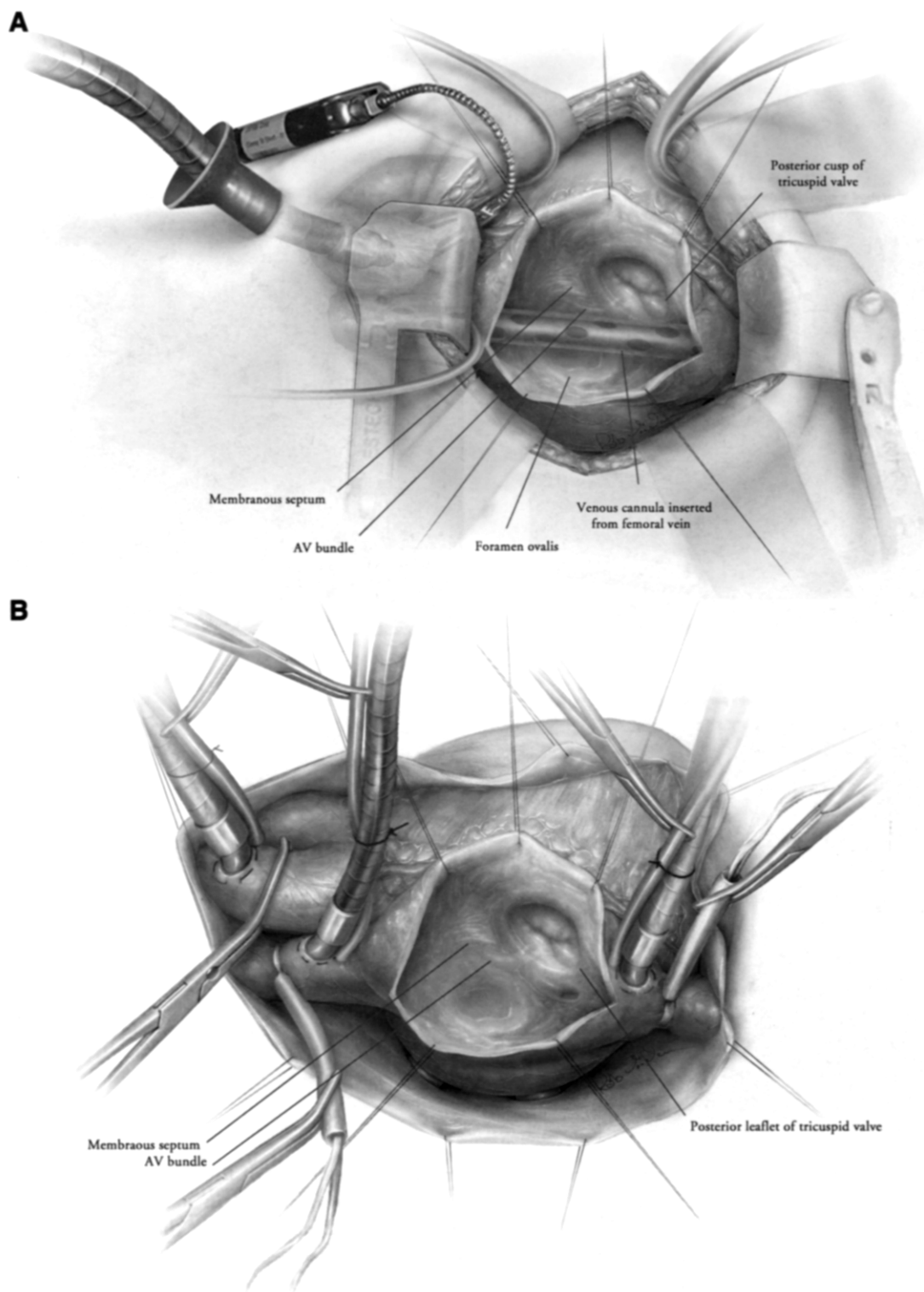
iology being dilation of the right ventricle and tricuspid annulus.⁵

Typically, the leaflets appear entirely normal. Interestingly, the posterior leaflet is most severely affected following tricuspid annular dilation, which can cause the base to lengthen by up to 80%. The anterior leaflet is less commonly affected (only up to 40% increase) whereas the septal leaflet, because of its attachment to the interventricular septum is usually unaffected (only up to 10% increase).^{5,6} This observation has given rise to the concept of tricuspid annular remodeling directed at the most affected area, the posterior segment. Posterior annuloplasty with obliteration of the posterior leaflet is our preferred method of tricuspid repair for functional disease.

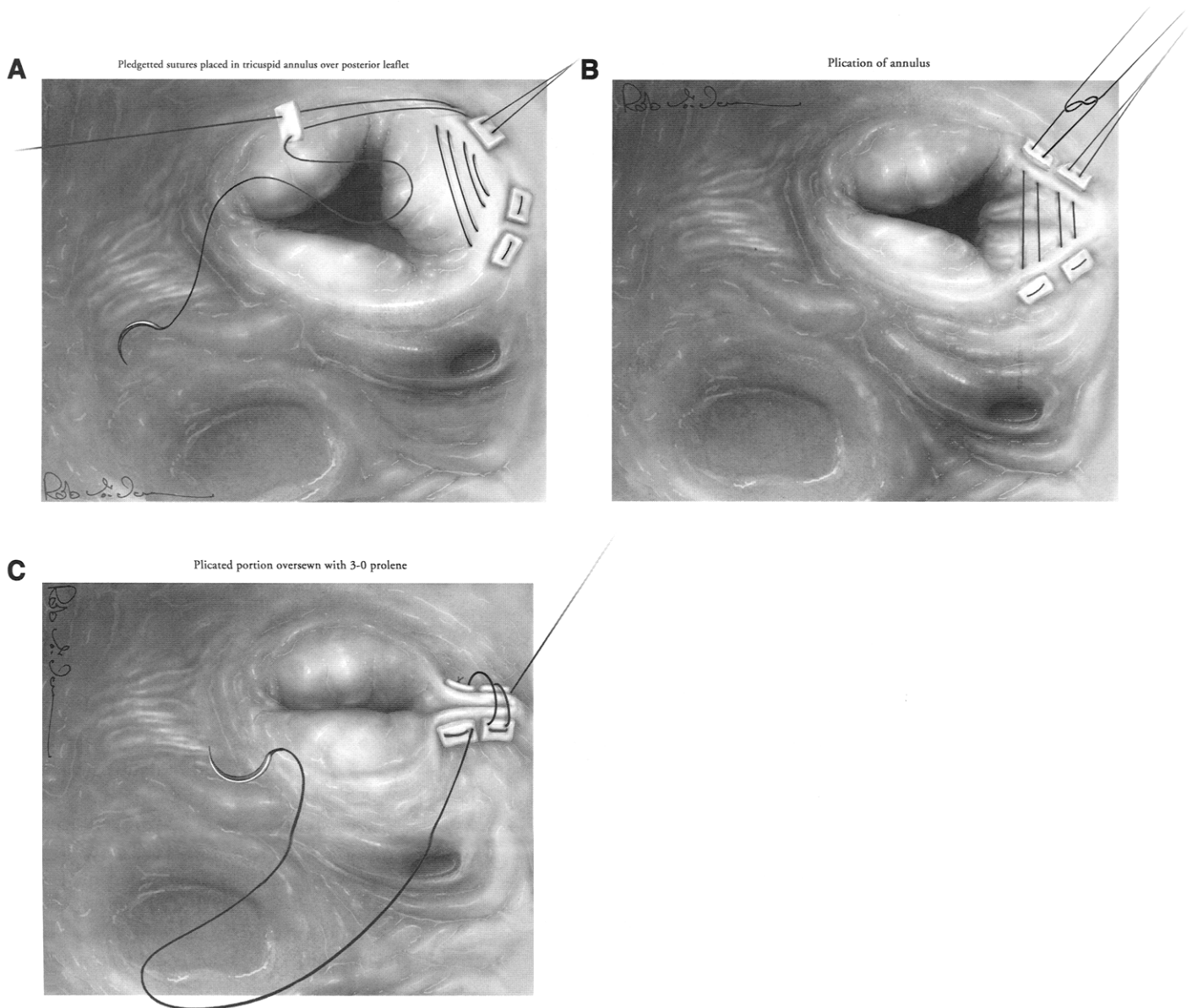
SURGICAL TECHNIQUE



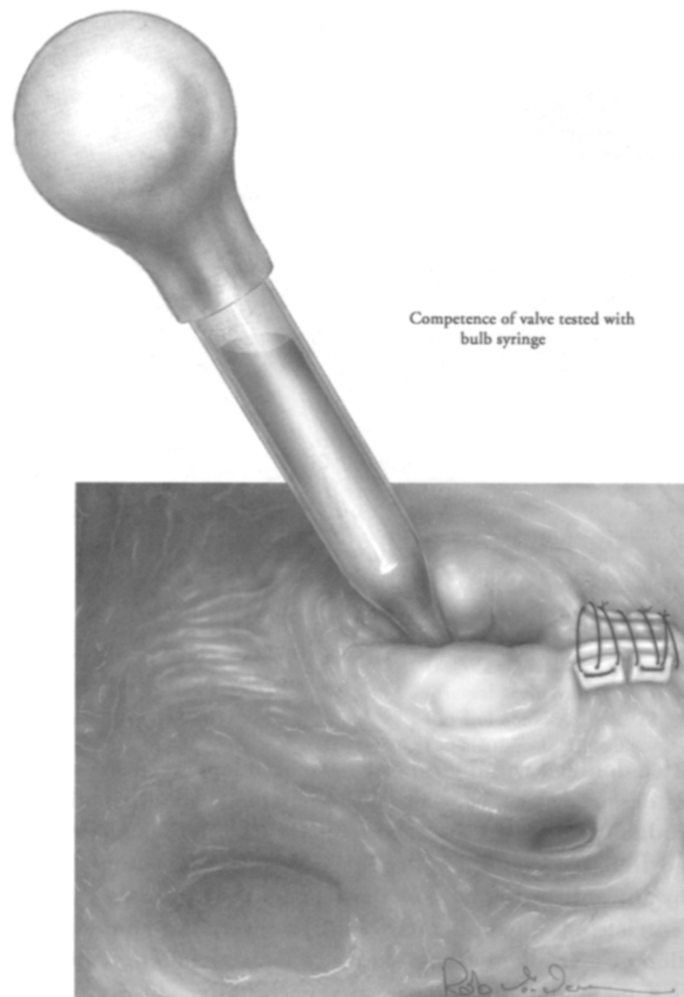
I The patient is positioned supine for a right anterior-lateral thoracotomy. A single-lumen endotracheal tube is used, without a bronchial blocker. With the arms placed alongside the body, the patient is prepped from the sternal notch to below the knees. Standard monitoring techniques include radial arterial line, central venous pressure, and urinary catheter with temperature probe. Transesophageal echocardiogram (TEE) is used in all cases. Tricuspid valve repair is usually performed as a concomitant procedure to mitral valve surgery. Since 1996, most mitral valve reconstruction procedures at our institution have been performed with minimally invasive techniques,⁷ using the following surgical approach. A skin incision (7-8 cm) is made over the fourth intercostal space in cases of mitral and tricuspid valve operations and over the third intercostal space in cases of triple valve disease (aortic, mitral and tricuspid valve surgery). After the chest has been opened, a soft tissue retractor and rib spreader are placed. The membranous portion of the diaphragm can be retracted inferiorly toward the chest wall with a heavy suture to improve exposure when a fourth interspace incision is used. After systemic heparinization, the ascending aorta is directly cannulated using an aortic cannula with an incising introducer (Straightshot, CardioVations, Somerville, NJ), placed through a separate port in the right second interspace in the mid-clavicular line or directly through the thoracotomy. A percutaneous 22F multi-hole long venous cannula (CardioVations, Somerville, NJ) is introduced from the femoral vein and positioned in the right atrium under TEE guidance,⁸ with the distal tip extending just into the superior vena cava. Carbon dioxide is delivered via a small IV tube into the thoracic cavity to flood the field to displace the ambient nitrogen.



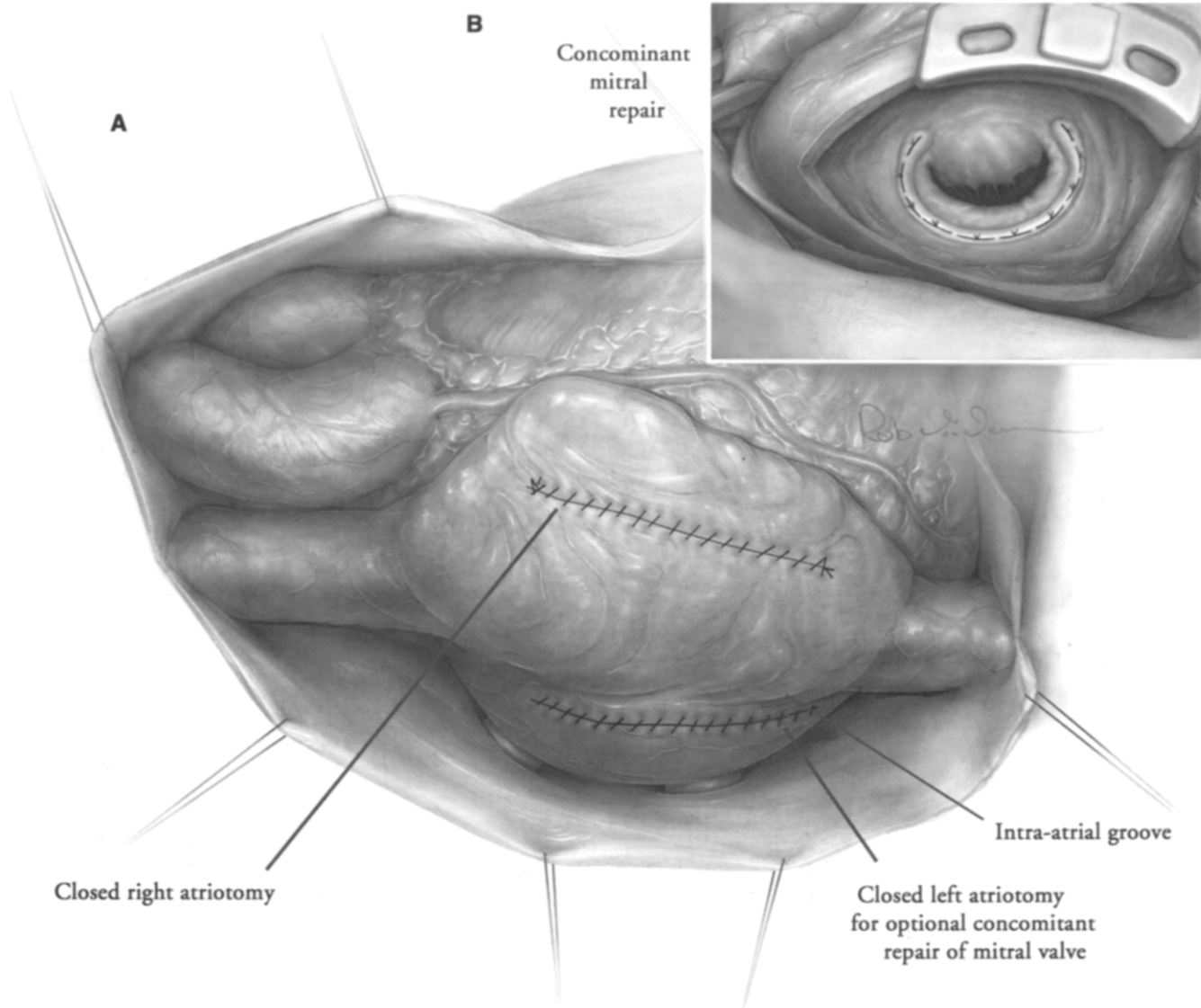
2 The aorta is then directly occluded with a flexible cross-clamp (Novare, Cupertino, CA) or a standard 90 degree angled aortic cross-clamp. Cold blood cardioplegia is administered antegrade or using a retrograde cannula placed into the open right atrium. We routinely use vacuum-assisted drainage in the cardiopulmonary bypass circuit. Therefore, using this method (A), it is unnecessary to snare the inferior and superior vena cavae over the cannula during the short period while the right atrium is open. When the tricuspid valve is approached using a median sternotomy, standard bicaval cannulation and snaring is used (B). The right atrium is opened parallel to and 1 cm from the atrio-ventricular groove. A stay suture retracts the superior edge of the opened right atrium providing unobstructed visualization and allowing careful inspection of the tricuspid valve.



3 An asymmetric annuloplasty is performed starting on either side in the center of the dilated posterior leaflet annulus.⁴ The repair is performed with braided, permanent 2-0 double ended sutures placed in a mattress fashion. Low-profile, long-shafted instruments are highly recommended. The first needle enters 2 mm deep on the atrial side of the posterior-anterior commissural annulus and exits through the leaflet tissue. The same needle is then passed back from the leaflet side deeply through the annulus and subsequently through a pledget. This is then repeated with the second needle, having advanced approximately the width of the pledgets (A). The entire repair usually requires two to three mattress-pledgetted sutures. As the sutures are tightened, the annulus is asymmetrically plicated, imbricating the posterior leaflet (B). An over-and-over monofilament 4-0 suture may be used to reinforce the braided sutures if needed (C). The resulting orifice should accept two fingers (approximately 5 cm).



- 4** Valvular competence is visually inspected with saline injection by a bulb syringe into the right ventricle as mild pressure is placed on the outflow tract of the right ventricle.



5 The right atrium is closed with a doubled running row of 4-0 monofilament sutures (A). The suture ends are not tied until the right heart has been completely de-aired. This is accomplished by placing a fibrillating wire on the heart and releasing the aortic cross-clamp. The heart is gradually filled with gradient from the cardiopulmonary bypass circuit. The right atrial suture line is loosened and a large curved Debaquey clamp is introduced through the suture line across the repaired valve into the ventricle to provide an exit path for any entrapped air. For those patients with massive right ventricle dilation, we use a needle to aspirate the body of the right ventricle and the pulmonary outflow tract. The annuloplasty is adjusted if there is more than trace residual tricuspid regurgitation or a gradient across the valve more than 3 to 4 mm. Concomitant mitral procedures are performed in most cases using the same minimally invasive approach. After closure of the right atrium, the mitral valve is exposed with an intraatrial blade retractor allowing for mitral valve repair (B).

Comments

It is difficult to predict the natural history and prognosis of patients undergoing mitral valve surgery with ignored significant tricuspid insufficiency.⁹ Although the surgical risk of mitral plus tricuspid valve surgery is higher than that with isolated mitral procedures, the increased risk may be related to advanced valvular cardiomyopathy with right ventricular decompensation.¹⁰ In the current era of TEE, intraoperative manual palpation of the tricuspid valve “feeling for a jet wash” is no longer necessary. Rather, the decision to

repair the valve is made based on the preoperative clinical status of the patient and the TEE assessment of the tricuspid insufficiency

Patients with chronic mitral regurgitation (MR), particularly those with normal or reduced left atrial compliance, have little enlargement of the left atrium but have marked elevation of the mean left atrial pressure. This produces symptoms of congestive heart failure with increased pulmonary vascular resistance. The subsequent right ventricular hypertrophy and dilation may cause functional tricuspid insufficiency. It has

been shown that tricuspid regurgitation is not significantly reduced after mitral valve disease is corrected.⁴ Moreover, uncorrected functional tricuspid insufficiency after surgical repair of left-sided valvular lesions has an adverse effect on early and late results^{11,12} and leads to progressive right heart failure.¹³ Therefore, tricuspid valve annuloplasty at initial mitral valve replacement has been recommended¹⁴ and surgical treatment of significant tricuspid insufficiency associated with left-sided valve disease is now widely accepted.^{15,16} However, proper repair with satisfactory early and late results still remains a challenge for the cardiac surgeon. Therefore, we recommend that mild degrees of tricuspid insufficiency should be left alone, especially in the absence of pulmonary hypertension. However, repair is recommended whenever tricuspid regurgitation is more than moderate.

Early prosthetic replacement of the tricuspid valve has produced disappointing results, with mortality up to 36%.^{4,5} Therefore, several methods for tricuspid insufficiency repair have been suggested. These included suture annuloplasty of the posterior ring with plication of the posterior leaflet,^{4,17,18} De Vega method,¹⁹ rigid ring annuloplasty,²⁰ and flexible ring.^{21,22} Although the potential advantages of a flexible ring annuloplasty system remain largely speculative, the notion of preserving right ventricular function and tricuspid annular contraction with this ring has been suggested.¹⁶

In the majority of patients, tricuspid insufficiency is related to dilation of the annulus. Therefore, virtually all such patients can be treated by posterior annuloplasty. Our experience with more than 300 patients from our institution shows that the posterior leaflet annuloplasty is simple, safe, and reproducible in the absence of significant intrinsic leaflet disease.

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