Basis for Intervention on Functional Tricuspid Regurgitation

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Functional tricuspid regurgitation is a complex valvular lesion. Its optimal management remains controversial in the current era as the result of uncertainties regarding accurate diagnosis, surgical indication, the appropriate surgical procedure, and the late results of surgical treatment. It is no longer regarded a benign problem and does not resolve spontaneously after correction of left-sided heart valve lesions as once believed. It carries a significant morbidity and has an adverse impact on survival. Current techniques to repair functional tricuspid regurgitation are associated with a significant degree of residual or recurrent regurgitation mainly because of failure to address all the components of this challenging entity. This review article highlights emerging concepts and advances that provide an insight into the understanding of this perplexing lesion and attempts to define the basis of intervention on functional tricuspid regurgitation.

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Functional tricuspid regurgitation is common in patients undergoing operations for left-sided heart valve disease, with a reported prevalence between 25% and 30%.[1-3] Functional tricuspid regurgitation has many causes related to dilation of the tricuspid annulus and tethering of the tricuspid valve leaflets secondary to right ventricular (RV) dysfunction.[4,5] Historically, concomitant tricuspid valve repair was less commonly performed because of the observation that functional tricuspid regurgitation often improves after left-sided heart valve operations.[6] Contemporary evidence, however, suggests that tricuspid repair should be considered more often given that uncorrected functional tricuspid regurgitation is associated with poor survival and functional status.[1-3,7,8] As a result, the optimal management of patients with functional tricuspid regurgitation at the time of left-sided heart-valve surgery continues to evolve. Although in recent times it has been established that patients with moderate-to-severe functional tricuspid regurgitation should have concomitant tricuspid-valve repair, the management of mild functional tricuspid regurgitation at the time of left-sided heart-valve surgery remains controversial.[9]

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Another important issue that complicates management of functional tricuspid regurgitation is recurrent, progressive or residual regurgitation after surgical intervention using current techniques.[10-14] This review article attempts to define the basis of intervention to treat functional tricuspid regurgitation and also to prevent residual or recurrent tricuspid regurgitation taking into account the emerging concepts and advances that provide an insight into the understanding of this perplexing lesion.

CORRECTION OF ANNULAR DILATION AS THE BASIS FOR INTERVENTION ON FUNCTIONAL TRICUSPID REGURGITATION

Contrary to the traditional view, correction of left-sided valvular disease does not automatically correct functional tricuspid regurgitation.[15] Treatment of the mitral lesion alone only decreases the afterload. It does not correct tricuspid dilation, nor does it affect preload or RV function.[16] Dilatation of the tricuspid annulus is progressive and may not be accompanied by tricuspid regurgitation initially, but eventually leads to it.[16]

The normal tricuspid valve annulus is a bimodal nonplanar structure with distinct high points located anteroposteriorly and low points located mediolaterally. It is known that with functional tricuspid regurgitation the annulus becomes larger, more planar, and circular. The flattening of the tricuspid valve annulus that occurs with tricuspid regurgitation can potentially alter the normal papillary muscle-to-leaflet and annulus relationship. With flattening of the annulus, the low points of the annulus may be

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Table 1. Impact of Tricuspid Valve Repair at the Time of Mitral Valve Repair on Progression of Tricuspid Regurgitation*

	Before Surgery		After Surgery	
	Group 1 (MVR)	Group 2 (MVR + TVR)	Group 1 (MVR)	Group 2 (MVR + TVR)
Grade 0	54	38	8	102
Grade 1	102	92	33	41
Grade 2	7	16	67	34
Grade 3	0	2	40	1
Grade 4	0	0	15	0
Mean TR grade	0.7 ± 0.5†	0.9 ± 0.6†	2.1 ± 1.0‡	0.4 ± 0.6‡

MVR, mitral valve repair; TVR, tricuspid regurgitation.
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*Measurements by transthoracic echocardiography.
†$P = 0.027$, Mann–Whitney.
‡$P < 0.001$, Mann–Whitney.

stretched away from the papillary muscles, thereby increasing tethering.[17]

The tricuspid annulus is a component of both the tricuspid valve and the right ventricle.[16] Ton-Nu et al[17] suggest that it is not the RV pressure load or left-sided heart disease that influences the annular remodeling changes observed with functional tricuspid regurgitation. It is the RV dysfunction and dilation that affect those annular remodeling changes. As suggested by Ton-Nu et al,[17] the RV dysfunction and tricuspid regurgitation are indeed linked, perhaps through the mechanism of annular shape. Possibly, the tricuspid annulus can be thought of as the "gear" that modulates the effects of RV remodeling on tricuspid valve function.

The presence of secondary tricuspid pathology is often not appreciated, especially if severe tricuspid regurgitation is not present. Although there is no question that considerable tricuspid pathology is present when there is severe tricuspid regurgitation, considerable tricuspid pathology may also be present when the severity of tricuspid regurgitation is only mild or moderate[18] because the assessment of the tricuspid valve at a given time by echocardiography is dependent upon the preload and afterload conditions of the patient, and these conditions may vary from time to time. The absence of tricuspid regurgitation or the presence of only mild tricuspid regurgitation does not mean that the tricuspid orifice is free of any abnormality, such as tricuspid annular dilation.

Because the grading of tricuspid regurgitation is highly subjective, and because there is considerable variation in the severity of tricuspid regurgitation depending on RV preload, afterload, and contractility, we have proposed that a decision to perform concomitant tricuspid valve surgery at the time of left-sided heart-valve surgery in patients with less than severe tricuspid regurgitation should be determined by the tricuspid annular diameter.[16] It is unlikely that patients with no or trace tricuspid regurgitation will develop significant tricuspid regurgitation late after left-sided heart-valve surgery if the tricuspid annulus is not dilated at the time of the initial surgery. Conversely, it is very likely that significant tricuspid regurgitation will develop in these patients if significant tricuspid annular dilation is present and is not corrected at the time of left-sided heart-valve surgery (Table 1).[16]

We directly measure the size of the tricuspid annulus at the time of mitral valve surgery and repair the tricuspid valve concomitantly if the tricuspid annulus is dilated beyond 70 mm, which is twice its normal size. In our series of 311 patients, we found that 48% of our patients had such tricuspid annular dilation, even though the majority had no more than trace tricuspid regurgitation.[16] Functional class at late follow-up was significantly improved in those patients who had a concomitant tricuspid valve repair compared with those who did not. Such intraoperative measurement of the tricuspid annulus size is highly reliable and reproducible, and measures the maximum tricuspid annulus in the fully relaxed, arrested heart from the anteroseptal commissure to the anteroposterior commissure.[16] It should be noted that this differs from echocardiographic measurement of the tricuspid annular diameter. A typical 4-chamber echocardiographic view would measure the tricuspid annulus from the middle of the septal annulus to the middle of the anterior annulus. It has been suggested that using echocardiographic measurements, a tricuspid annulus diameter of greater than 40 mm or 21 mm/m^2 measured in the 4-chamber view should indicate the need for concomitant tricuspid valve repair.[19] We therefore recommend that in patients with less than severe functional tricuspid regurgitation the tricuspid annular diameter should be measured, and if this is dilated beyond 70 mm as measured directly in the operating theater