Percutaneous Tricuspid Annuloplasty

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KEYWORDS

• Tricuspid regurgitation • Right-sided heart failure • Tricuspid annuloplasty

KEY POINTS

- The tricuspid valve was ignored for a long time.
- The prevalence of severe tricuspid regurgitation, however, is not negligible and is associated with poor prognosis.
- In cases of primary tricuspid regurgitation, surgical options are limited by a high risk of mortality and morbidity.
- New percutaneous approaches are becoming available to meet this consistent unmet clinical need.
- This review presents the current available devices that reproduce both the complete and uncomplete surgical annuloplasty techniques.

INTRODUCTION

Functional tricuspid regurgitation (FTR) represents the most frequent type of tricuspid regurgitation (TR) encountered, whereas TR caused by primary (organic) valve lesions is uncommon.[1] FTR (also known as secondary TR) can be the result of left-sided valvular or myocardial dysfunction or of pulmonary hypertension in absence of organic disease of the tricuspid valve.[2] In approximately 20% of cases, FTR is secondary to a primary dilation of the right atrium and/or ventricle. The final common pathway resulting in FTR is invariably tricuspid annular dilatation that occurs mainly in the posterior and anterior parts of the valve (along the right ventricular free wall). When annular dilation occurs, the annulus loses its usual saddle shape and becomes flattened. The enlargement of the right ventricle and tricuspid annulus creates the anatomic basis of TR due to the lack of leaflet coaptation.[3] In the advanced stage of the disease, worsening of the TR is caused by a progressive increase in the annular and right ventricular chamber diameters. When this occurs, reducing the tricuspid annular diameter with annuloplasty has been the primary target in the surgical treatment of FTR.[4] Many patients suffering from severe TR, however, remain untreated because of prohibitive surgical risk. In this setting, emerging percutaneous tricuspid annuloplasty devices have been developed to satisfy this unmet clinical need.

SURGICAL BACKGROUND

The surgical repair of TR secondary to annular dilation can be performed using 2 surgical methods: (1) suture annuloplasty and (2) ring annuloplasty.[5]

The purpose of suture annuloplasty is to reduce annular dimensions by using a surgical suture technique (usually with pledgets) to

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purse-string the annulus. Most suture annuloplasty techniques replicate either the technique popularized by Taramasso and colleagues[6] or the De Vega annuloplasty. The Kay annuloplasty technique results in bicuspidization of the tricuspid valve by plicating the posterior leaflet. The De Vega technique is based on suturing the annulus surrounding the anterior and the posterior leaflets, improving leaflet coaptation. The durability of suture annuloplasty is limited, however, due to inadequate or recurrent annular dilation, which can be related to suture dehiscence due to the presence of friable tissue.

Ring annuloplasty consists of the implantation of a prosthetic annuloplasty ring. Rigid rings are able to effectively reduce the tricuspid annular diameter and improve leaflet coaptation and have been shown more durable than suture-based annuloplasty in surgical series. Some rings can also restore the native 3-D shape of the tricuspid annulus. A rigid ring can interfere, however, with the physiologic systolic and diastolic excursion of the tricuspid annulus during the cardiac cycle.[7] Flexible bands have an adaptive movement in synergy with tricuspid annulus excursion but have worse results in terms of TR recurrence.[8]

ANATOMIC CHALLENGES FOR PERCUTANEOUS TRICUSPID ANNULOPLASTY

Several percutaneous annuloplasty systems are based on established surgical techniques. These percutaneous technologies address the predominant pathophysiologic mechanism of FTR, which is annular dilatation. Several anatomic factors may represent a challenge, however, for the percutaneous treatment of FTR[9]:

- The target zone for percutaneous tricuspid annuloplasty is the anterolateral part of the tricuspid annulus, which is in close proximity with the right coronary artery (RCA).[10]
- Few percutaneous routes are available to achieve an ideal approach for the percutaneous treatment of the tricuspid valve. The thin wall of the right ventricle does not allow the transapical approach. The transfemoral venous route is limited by the frequently unfavorable angle between the tricuspid annulus and inferior vena cava. Access from the internal jugular vein or superior vena cava has a more favorable approach angle to the tricuspid valve, but gaining access in the neck can be ergonomically awkward in the catheter laboratory environment. The small subvalvular space and the high number of trabeculae limit the possible movements below the valvular plane.
- Due to large native tricuspid annular diameters, the introducer sheath and the delivery system need to accommodate a prosthesis approximately twice the size of the prostheses used for transcatheter aortic valve replacement.
- Lack of widespread knowledge on the performance of standardized imaging required for the interventional guidance of transcatheter tricuspid procedures. Transesophageal echocardiography is limited by the anterior location of the valve. 2-D echo has the limitation that it can rarely visualize the 3 leaflets together. Moreover, the esophagus is not axial with nor in close proximity to the tricuspid valve so midesophageal images are off-axis and, therefore, more challenging to orient. 3-D echocardiography has overcome this problem by giving simultaneous visualization of the 3 leaflets; however, poor acoustic windows in some patients and a lack of standardization of imaging views is a major limitation.[11] There is limited experience with the use of intracardiac echocardiography, although this has the advantage of being in the right atrium and can provide highly detailed imaging if aligned correctly.
- Current devices dedicated to percutaneous tricuspid annuloplasty require a certain amount of space between the RCA and the tricuspid annulus (to avoid injuring the RCA) as well as a good tissue quality.[12]
- The tricuspid valve and annulus poses several anatomic challenges. The contemporary available devices for percutaneous tricuspid annuloplasty require good-quality tissue and enough space between the tricuspid annulus and the RCA to be safely implanted. The late device detachments and tissue dehiscence that occurred after first percutaneous experiences can be a consequence of tissue fragility that limit safe and prolonged anchoring of the devices.[13]