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Comparison between different methods used for tricuspid valve repair for functional tricuspid regurge

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Abstract---Background: Severe functional tricuspid regurgitation represents an important unmet need in clinical cardiology given its prevalence, adverse prognostic impact and symptom burden. Surgical tricuspid valve annuloplasty remains the treatment of choice for the majority of patients, especially if the operative risk is acceptable and preserved right ventricular function is present. However, several trans-catheter techniques are currently in bench and early clinical testing to provide alternative treatment options for patients with a very high surgical risk. The aim of this study was to compare between different methods used for tricuspid valve repair for functional tricuspid regurge. Summary: Ring annuloplasty for secondary severe functional tricuspid regurge is significantly better than Devega procedure in mid-term outcome, regarding residual regurge and right ventricular remodeling. Although both procedure are equally effective in early postoperative period.

Keywords---pulmonary hypertension, right ventricle, trans catheter therapy, tricuspid regurgitation, tricuspid valve.

Introduction

The tricuspid valve is usually considered a forgotten valve. This is because the other cardiac valves are more frequently addressed in the scientific literature ⁽¹⁾. The aortic and mitral valves are commonly involved in rheumatic disease showing gross changes after an acute or chronic inflammatory reaction. The diseases of the tricuspid valve frequently present in the form of regurgitation, which is functional secondary to left sided valvular or myocardial disease with subsequent pulmonary congestion, right ventricular hypertrophy and dilatation with subsequent annular enlargement.⁽²⁾ The gross anatomy of the tricuspid valve is seldom seriously affected as to require replacement regardless of the disease. ⁽³⁾ On the other hand, the mechanisms of tricuspid valve normal and abnormal function are well known for decades and what is clear is that right ventricular contractility is a key component of tricuspid valve function and that left-sided lesions do influence on the valve function as well. ^(4, 5)

Replacement of the tricuspid valve is, in fact, an uncommon clinical operation in current times as repair conveys good long-term results. In the specific case of rheumatic valve disease it is clear that survival is better and reoperation less frequently required when the tricuspid valve is repaired. ^(5, 6) Considering all of the above, it might be of interest to briefly review current concepts and therapeutic attitudes towards functional tricuspid regurge. Non prosthetic repair ,Devega and bicuspidization of the tricuspid valve can be considered a very early type of repair without the use of prosthetic material, however, there were always concerns on residual tricuspid regurgitation that were addressed at a later stage which lead to introduction of prosthetically supported repairs.⁽⁷⁾

History

De Vega selective and adjustable suture-based repair is credited as one of the most popular valve operations in the past four decades since it was first reported in 1972. Technical tips are simple and this operation is a truly reproducible. Some concerns exist about somewhat unpredictable results. But forty years later this technique continues to be widely used. ⁽⁸⁾ A number of modifications of the De Vega procedure have also been described and clinically tested. Some focused on the segmental nature of the repair on top of the semicircular extension including the anteroseptal and posteroseptal commissures. ⁽⁹⁾

Epidemiology

Tricuspid regurgitation is frequently present in patients with mitral valve disease and more than one-third of patients with mitral stenosis have at least moderate TR.^{18,19} Severe TR has been reported in 23–37% of patients after mitral valve replacement for rheumatic valve disease.⁽¹⁰⁾ Functional TR is frequently observed in the advanced stage of left-sided valvular heart disease or myocardial disease ⁽¹⁰⁾

Functional Tricuspid Regurgitation

Functional tricuspid insufficiency exclusively due to annulus dilation and/or dysfunction is the most frequent cause of tricuspid disease. The leaflets, chords,

and papillary muscles are otherwise normal. In a necropsy study of patients with pure insufficiency, Waller et al.,⁽¹¹⁾ reported that 47% of all cases of tricuspid regurgitation were functional. In one of our studies,⁽¹²⁾ 54% of 253 mostly rheumatic patients who underwent tricuspid surgery had functional tricuspid disease, but 30% of these cases with organic disease also had a concomitant annular dilation. Because of the lack of an anatomical fibrous annulus, the tricuspid annulus follows the dilation of the right cavities and of the right ventricle in particular. The total perimeter of the normal annulus is approximately 100–120 mm.

In cases of functional tricuspid regurgitation, the circumference of the annulus can reach 150–170 mm^(11, 12). This annulus dilation is nonhomogeneous. In a postmortem study that included normal controls and hearts with rheumatic or myxomatous tricuspid disease, Carpentier and colleagues⁽¹³⁾ showed that the anterior and posterior segments of the annulus dilated far more than the septal portion. This report forms the basis for all annuloplasties that selectively reduce the whole annulus except at the level of the septum. Classically, the most frequent cause of this annular dilation is right ventricular pressure overload secondary to mitral disease. However, the absence of functional insufficiency in many congenital patients with severe pulmonary hypertension refutes this oversimplified view.⁽¹⁴⁾

Diagnosis

Very little precise clinical criteria exist to determine the presence and degree of tricuspid disease. The well-known clinical signs of tricuspid disease are unmistakable, but their absence does not exonerate the surgeon from suspecting and treating it. Clinical experience has repeatedly shown that although tricuspid regurgitation regresses spontaneously after correction of left-sided lesions in some patients, other patients require reoperation only to repair a previously ignored tricuspid valve. The symptomatology of the patient with tricuspid disease is usually minimal and overshadowed by the more apparent left-sided symptoms.

A more quantitative FTR assessment is provided by vena contracta width and proximal isovelocity surface area (PISA) measurement. Vena contracta represents the cross-sectional area of the blood column as it leaves the regurgitant orifice; it thus reflects the regurgitant orifice area. The vena contracta of the TR flow is typically imaged in the apical four-chamber view using a careful probe angulation to optimize the flow image, an adapted Nyquist limit (colour Doppler scale, 40–70 cm/s) to identify with clarity the neck of the jet, and a narrow sector scan coupled with the zoom mode to maximize temporal resolution and measurement accuracy.⁽¹⁵⁾ Averaging measurements over at least 2–3 beats is recommended. Vena contracta width >6.5 mm is usually associated to severe TR. Intermediate values are not accurate for distinguishing moderate from mild TR. A limitation of measuring vena contracta width is the fact that regurgitant orifice geometry is complex and not necessarily circular. This may explain the limited correlation between vena contracta width by 2D colour Doppler and 3D planimetry of effective regurgitant orifice area. With 3DE color Doppler, planimetered regurgitant orifice area >75 mm² has been associated with severe TR.⁽¹⁶⁾

Cardiac magnetic resonance

In the absence of specific contraindications, when echo imaging is limited by a suboptimal acoustic window, in patients with equivocal echocardiographic findings and when 3DE is not available for assessing RV volumes and function, CMR is the technique of choice to assess patients with significant TR.⁽¹⁷⁾ A significant and growing body of evidence suggests that ignoring a diseased tricuspid valve at the time of surgery for left-sided pathology will interfere with the eventual outcome of the patient. King and associates⁽¹⁸⁾ reported that 66% of patients returning for tricuspid valve surgery late after mitral valve replacement had only mild tricuspid valve insufficiency at the time of the initial operation. It must be noted that in some patients, this course of events was related to failure of the mitral operation (as evidenced by the fact that concomitant mitral surgery was necessary in half of the patients).

Porter et al.,⁽¹⁹⁾ studied a group of 65 patients with rheumatic heart disease who underwent mitral valve replacement without tricuspid surgery and were followed for up to 30 years (mean 11.3 years). Echocardiography revealed significant tricuspid regurgitation in 67% of the patients. In 34% of them, the lesion was organic and therefore present and presumably undiagnosed at the time of the initial surgery.

Surgical Indication in functional regurge

Functional tricuspid regurgitations should be surgically treated. Severe lesions are obvious candidates for repair. The old argument that the sudden increase in afterload after valve replacement would result in ventricular failure known as the “pop off” mechanism must be abandoned. Despite the well-known reduction in regurgitation under anesthesia, a useful intraoperative indicator for repair is the TEE measurement of the end-systolic tricuspid annulus. A maximum tricuspid diameter above 30 mm should constitute an indication for repair. In any case, patients should be referred for surgery before developing secondary liver cirrhosis or severe RV dysfunction since these conditions identify a very high-risk surgical population.⁽²⁰⁾ There is increasing evidence that patients undergoing mitral valve surgery would benefit from tricuspid annuloplasty when the TA is dilated independent on the severity of TR.⁽²¹⁾

Surgical Approaches to the Tricuspid Valve

The approach to the tricuspid valve is easy because of its anatomical location. It can be visualized through a median sternotomy or a right thoracotomy. Unless an isolated tricuspid lesion is contemplated, the type of thoracotomy and incision is dictated by the concomitant surgery. A standard or minimally invasive approach can be safely used.

Repair Maneuvers

Tricuspid Annuloplasty

The principle behind all tricuspid annuloplasties is to selectively reduce the length of the tricuspid annulus and, consequently, the tricuspid orifice. The lack of leaflet coaptation is compensated by the induced smaller tricuspid orifice. The earliest annuloplasties consisted of plicating the annulus at the level of the base of the posterior leaflet. This approach, borrowed from the early mitral annuloplasties, was described by Wooller et al.⁽²²⁾ and Kay et al.⁽²³⁾

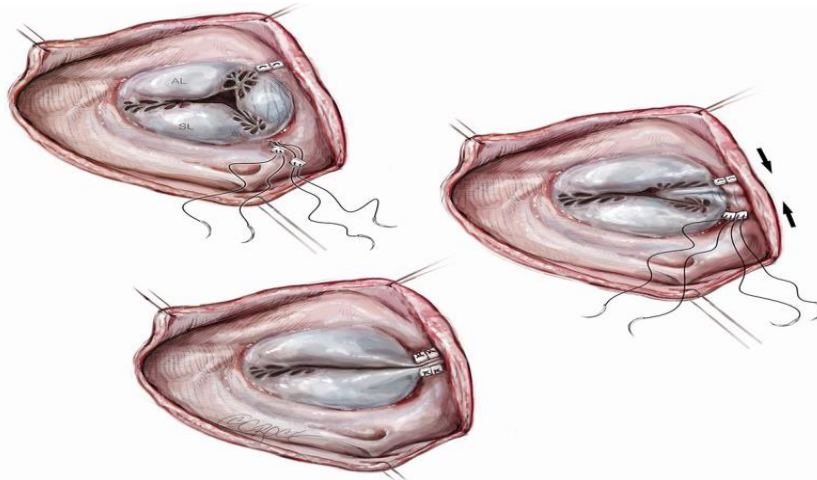


Figure (3): plication of posterior leaflet of tricuspid valve.⁽²⁴⁾

Bond et al. Tricuspid valve repair: innovative solution. *Ann cardiothoracic surg* 2017;6(3):248-254 doi:10.20137acs2017.05.06 Cabrol⁽²⁵⁾ and DeVega⁽²⁶⁾ independently described a partial encircling suture to narrow the annulus. The extremities of a double suture that runs along the base of the anterior and posterior leaflets are anchored with pledgets at the anteroseptal and posteroseptal commissures.

Ring annuloplasty

The surgical technique for implanting a tricuspid ring is very similar for all types of rings. The selection of the appropriate ring size is based on the length of the septal segment of the annulus. Large U sutures are placed around the annulus and through the ring. The ring is brought down, and the sutures are tied, reducing the overall perimeter of the tricuspid annulus.

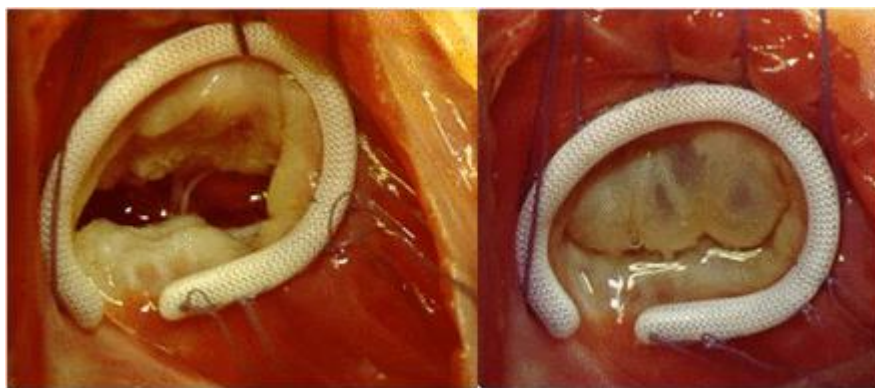


Figure (5): ring annuloplasty ⁽²⁷⁾

Outcome

The late appearance of tricuspid regurgitation accompanied by symptoms and signs of right heart failure is an important cause of late morbidity and mortality in patients undergoing mitral and aortic valve surgery. Recent studies have shown that significant tricuspid regurgitation is detectable by echocardiography in up to two thirds of patients late after mitral valve replacement, and that it is clinically apparent in more than one third of those patients. ⁽²⁸⁾ Irrespective of the etiology and type of surgery, results of tricuspid surgery have been rather poor; the majority of lesions operated are functional regurgitations that represent severe left side impairment, pulmonary hypertension, and right ventricular failure. The poor results of tricuspid surgery are therefore not surprising.

Conclusion

Ring annuloplasty for secondary severe functional tricuspid regurge is significantly better than Devega procedure in mid-term outcome, regarding residual regurge and right ventricular remodeling. Although both procedure are equally effective in early postoperative period

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