Adjustable tricuspid annuloplasty†

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Abstract

The methods for repairing functional tricuspid regurgitation (TR) are still controversial. A novel concept of tricuspid annuloplasty for functional TR was developed. A flexible annuloplasty band, through which an expanded polytetrafluoroethylene (ePTFE) thread (CV3) was passed inside the cover cloth, was secured to the tricuspid annulus. Both ends of the ePTFE thread were passed through the right atrial wall. The thread was snared from outside the ejecting heart under observation by a transoesophageal echocardiogram after weaning off the cardiopulmonary bypass. We used this technique in 11 patients with functional TR (mean TR grade: 3.4 ± 0.8). The mean circumference of the annulus after snaring was 86.5 ± 4.6 mm (diameter 27.6 ± 1.5 mm). The postoperative TR at discharge was trivial or 0 in 9 patients and Grade 1 in 2. We concluded that this method has the potential to minimize residual regurgitation.

Keywords: Tricuspid valve insufficiency • Functional tricuspid regurgitation • Tricuspid annuloplasty

INTRODUCTION

It is increasingly recognized that functional tricuspid regurgitation (TR) is not always resolved after correction of left-side heart disease [1–5]. Tricuspid annuloplasty (TAP), which uses an artificial ring or band, is widely accepted for use in the repair of TR [1–6]. The optimal morphology and size of the devices remain controversial [2–6]. We have developed a novel adjustable technique for TAP.

MATERIALS AND METHODS

In order to prepare the device, an expanded polytetrafluoroethylene suture (CV3, ePTFE, W.L. Gore and Associates, Flagstaff, AZ, USA) was passed inside the cover cloth of a 29-mm Tailor Annuloplasty Band (St Jude Medical, St. Paul, MN, USA) from both ends, and then out through the middle of the band. The needles were driven through end-first to prevent misinsertion. Marks indicating a length of 10 cm were made on the middle portion of the ePTFE thread using a skin marker pen (Fig. 1). Under direct view of the tricuspid valve, as indicated by dents of the obturator, two marks indicating the ends of the band were made on both sides of the conduction system on the tricuspid annulus (TA). Pledged 2-0 braided polyester sutures were stitched in mattress fashion first in those marks on TA and then in both ends of the band, and ligated. A continuous over-and-over suture was made in the TA from both sides of the conduction system to commissure between the anterior and posterior leaflets. Sutures were not stitched into the band; rather, the band was wound and secured on the entire annulus with the exception of the anterior part of the septal leaflet. An ePTFE Gore-Tex thread was stretched over the conduction system of the annulus, crossing over the space between the two ends of the band. Next, both ends of the ePTFE thread were passed through the right atrial wall and held outside the heart with a pledget (Fig. 2). Then, the right atrial wall was closed. After weaning off the cardiopulmonary bypass and reaching a stable haemodynamics, once residual regurgitation was detected, the ePTFE thread was snared under the observation of the transoesophageal echocardiogram. The markers on the thread were helpful in detecting the circumference and diameter of the TA.

We used this technique in 11 patients (mean age: 73.8 ± 7.7 years, 3 males). Preoperative TR grade was 2–4 (mean 3.4 ± 0.8); 8 patients had atrial fibrillation; and the mean systolic tricuspid pressure gradient estimated by TR velocity measured by Doppler echocardiography was 39.4 ± 20.2 mmHg. All of the patients had concomitant procedures performed on the left side of the heart.

RESULTS

All the patients were alive. The mean circumference of the TA after snaring the thread was 86.5 ± 4.6 mm (diameter 27.6 ± 1.5 mm). Postoperative TR at 2–4 weeks after surgery was trivial or 0 in 9 patients, and Grade 1 in 2.

DISCUSSION

Recently, much attention has been focused on the morphology and function of the tricuspid valve, and on the methods and prognosis of the surgical correction for TR [1–8]. A normal TA is an oval

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the ePTFE thread was passed inside the cover cloth of a 29-mm Tailor Annuloplasty Band from both ends, and then out through the middle of the band. The thread crossed over the space between the ends of the band. Marks indicating a length of 10 cm were made in the middle portion of the thread using a skin marker pen.

Three-dimensional saddle-shape and contracts 29.6% during systole [7]. When TR occurs, not only does the TA become enlarged, but the following also occurs. The TA becomes flat and round, and thus loses its oval, saddle-shape; and the valve leaflet becomes tethered to the right ventricle [7, 8].

Several methods have been developed for use in the repair of TR [2-5]. TAP using an artificial ring or band reportedly obtains better results than other methods using sutures or pericardial strips [2, 3, 5, 6]. Yet, the recurrence of TR after repair is not uncommon, and residual TR has an impact on morbidity and mortality [1, 5]. Risk factors for residual and recurrent TR are reported preoperative TR grade [5, 6], age [5, 6], tethering distance [5, 6], ventricle dysfunction [5, 6], atrial fibrillation [4], large TA (>28 mm) [1], methods of TAP [5] and TR at discharge [4]. Because tricuspid chordae are tethered in TR patients, the size of the anterior leaflet does not accurately indicate the size of the annulus and suitable device. Because the right side of the heart is fragile and collapsed during the use of the heart-lung machine, it is not easy to obtain evidence of a complete correction by the water seal test. For these reasons, we felt it impractical to attempt to determine the shape and diameter of the TA under direct vision.

We chose the tailor band for its pliability, since it changes length when the ePTFE thread is snared, and since it may change shape and diameter according to the cardiac cycle and remodeling in the chronic phase. When snared, the band prevents tear of the TA, causing the guitar string phenomenon. Artificial mitral chordae prove the durability of the ePTFE under left ventricle pressure. In addition, ePTFE shows a slippery nature. Then, we use a heavy ePTFE thread to snare the annulus.

Nava et al. [3] reported that the TAP using the rigid ring provided less-residual TR than that while using the flexible ring; yet there was no difference in mortality. The rigid ring reduced TR shortly after surgery, and the increasing ratio for the follow-up period was the same as for the flexible ring. Jeong and Kim [4] reported that less TR at discharge is an important factor for reducing the recurrence of TR in the chronic period after TAP. These reports suggest that reducing TA over the short term minimizes long-term TR after surgery. Our adjustable TAP minimized postsurgical TR. We believe our method offers one solution for reducing residual TR.

Study limitations

Our study did not have control groups. It is difficult to gauge accurately the morphology and function of the right ventricle. This is because the right ventricle is oval and saddle-shaped as it mutates easily according to the occasional function of the left ventricle. In the patients we reviewed on this occasion, we were unable to obtain reliable data on the function and morphology of the right ventricle. Precise data and a long-term follow-up are mandatory to evaluate the effects of the methods.

Conflict of interest: none declared.

REFERENCES

eComment. Adjustable tricuspid annuloplasty for functional tricuspid regurgitation

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Functional tricuspid regurgitation (FTR) is a neglected and underestimated pathology. It occurs mostly from annular dilatation and right ventricular enlargement, which is frequent secondary to left-sided heart failure from myocardial or valvular causes, right ventricular volume and pressure overload, and dilatation of the cardiac chambers. Moderate-to-severe FTR should be corrected to improve short- and long-term outcomes in patients undergoing surgery for left-sided valvular diseases. Tricuspid annuloplasty is a safe and effective surgical option for FTR and seems to be associated with an improvement in both functional status and survival.

I read with great interest the paper by Iida et al. [1]. They described a novel technique of adjustable annuloplasty for FTR employed in 11 patients. In their technique, an expanded polytetrafluoroethylene thread was passed inside the cover cloth of a flexible annuloplasty band. They tightened the thread with extradacrical control on beating heart under observation by transoesophageal echocardiography (TEE) after weaning off cardiopulmonary bypass (CPB). I would like to add a short comment on this annuloplasty technique.

For the last four decades, various repair techniques have been described for the surgical correction of FTR with severe tricuspid annular dilation. These broadly include ring annuloplasties (flexible and rigid prosthetic rings or three-dimensional rings, flexible prosthetic bands) and suture annuloplasties such as bicuspidization (Kay annuloplasty) or semicircular (De Vega annuloplasty). Other approaches may include the edge-to-edge technique (Alfieri-type) or anterior tricuspid leaflet augmentation to increase leaflet coaptation and relief of tethered leaflets [2]. The selection of the appropriate repair is the most important issue in the management of FTR. Although ring annuloplasty seems to increase durability of valve repair, the De Vega annuloplasty modifications are still advocated because of their good results.

To adjust the constrictor of tricuspid annulus on the beating heart, after discontinuation of CPB, Alonso-Lej [3] described an adjustable modification of the De Vega annuloplasty. Herein, extracardiac control of suture annuloplasty was gained by taking both ends of the suture through the wall of the right atrium after weaning off CPB. The degree of tricuspid regurgitation now is evaluated solely with TEE rather than with digital palpation [3].

Adjustable segmental tricuspid annuloplasty is a new modified technique that tries to reduce the incidence of failure in the De Vega annuloplasty and adjusts and distributes the purging forces in the more dilated area. Sarraj et al. [4] have used two separate sutures, and they have chosen the middle point between the anteroesopha
gest commissure and posteroseptal commissure to perform the purse-string technique. These new modifications make the technique more selective in the remodelling of the tricuspid annulus. Choi et al. [5] described a modified technique of tricuspid ring annuloplasty to reduce postoperative residual regurgitation in patients with FTR, first, an adjustable segmental tricuspid annuloplasty is performed to obtain coaptation of the valve leaflets with two 5-0 monofilament annular sutures, and then a prosthetic ring of the same size as the competent valve area is implanted with continuous 3-0 polypropylene sutures. Finally, I think that continued follow-up should be mandatory for confirming the effectiveness of these tricuspid annuloplasty techniques.

Conflict of interest: none declared

References


eComment. Beyond the tricuspid annuloplasty techniques

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We have read with great interest the article by Iida et al. [1]. This is a very nice technique and it seems that it works well. However, the core of tricuspid repair continues to be the use of a prosthetic ring. In fact, better long-term outcomes are obtained with prosthetic rings than with suture annuloplasty, with an incidence of residual severe tricuspid regurgitation (TR) of 12% vs 32% at 5 years, respectively [2, 3]. Much attention has been focused on the importance of the guidelines of the management of valvular heart disease [4]. Nevertheless, at a glance, the surgeon can note that the level of evidence is C for absolutely all kinds of recommendations. That is, these are based exclusively on consensus of opinion of the experts and/or small studies, retrospective studies or registries. There is no data derived from multiple randomized clinical trials or meta-analyses. All the above has particular importance because beyond the tricuspid annuloplasty techniques, we move into the difficult terrain of surgical practice and decision making where there are no easy or ‘pure’ solutions. Particular attention must be addressed with great care to identify patients with right ventricular (RV) dysfunction. Today, we know that tricuspid annular plane systolic excursion (TAPSE) (<15 mm), tricuspid annulus systolic velocity (<11 cm/s), and RV end-systolic area (>20 cm²) could be used with this aim [5]. At present, there are no precise statistical data available on irreversible RV dysfunction in patients with severe TR undergoing left-sided valvular surgery. The concept that all TRs can be operated is worthy of further discussion. In this pool of patients with irreversible RV dysfunction, tricuspid annuloplasty could perhaps worsen the postoperative outcome by removing the only natural escape hatch of a deteriorated and poor RV. Moreover, perhaps these patients should be considered as inoperable.

Conflict of interest: none declared

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