Tricuspid leaflet augmentation to address severe tethering in functional tricuspid regurgitation

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Abstract

This paper describes a technique for treating severe tricuspid regurgitation due to severe tethering of the tricuspid valve leaflets. The anterior tricuspid leaflet is augmented by use of an autologous pericardial patch, which increases its size, and hence its surface area of coaptation, allowing increased leaflet coaptation to occur with reduced tension within the right ventricle. A Carpentier—Edwards annuloplasty ring is then implanted. We have successfully performed this operation in 15 patients with severe tricuspid regurgitation due to severe leaflet tethering and have achieved complete elimination of tricuspid regurgitation with good coaptation of the tricuspid leaflets. We describe this simple and easily reproducible technique to treat severe tricuspid regurgitation due to tethering of the tricuspid valve leaflets.

Keywords: Tricuspid regurgitation; Tricuspid tethering; Annuloplasty

1. Introduction

Functional tricuspid regurgitation (TR) occurs secondary to dilatation of the tricuspid annulus and tethering of the valve leaflets from right ventricular (RV) dilatation and dysfunction [1,2]. It can be treated by various techniques including ring annuloplasty for which excellent results have been reported for mild or moderate TR due to annular dilatation [2]. However, there is a recurrence rate of 15—30% following tricuspid ring annuloplasty for severe TR and severe leaflet tethering is a risk factor for such recurrence [3,4]. A repair technique to address such severe leaflet tethering has been used at our institution which we will describe in this paper.

2. Technique

Preoperative echocardiographic assessment includes determination of the tricuspid annular diameter and the tethering height (distance between the tricuspid annular plane and the coaptation point between the anterior and septal leaflets) in a four-chamber view. Annular dilatation is defined as an annular diameter greater than 40 mm in diastole and severe tethering as a tethering height greater than 8 mm at mid-systole as previously reported [5].

All patients are operated through median sternotomy, double venous cannulation, and cardiopulmonary bypass at normothermia and antegrade cold blood cardioplegia. The right atrium is opened parallel to the atrioventricular groove. The anterior leaflet is detached along its entire length from its annular attachment extending from the anteroseptal to the anteroposterior commissure (Figs. 1a and 2a). A patch of autologous pericardium is harvested. This is cut into an oval shape to fill the defect with the aim of following the anterior leaflet to obtain the coaptation surface and the pericardial patch to be the main body of the leaflet (Fig. 2d). The diameter of this patch is therefore the distance between the anteroseptal and the antero-posterior commissure and its height is the greatest distance between the detached leaflet and the annulus. The patch is sutured on one side to the annulus and on the other side to the detached free edge of the anterior leaflet using a running 5/0 Cardionyl \( ^{\circ} \) suture (Peters Surgical, Bobigny Cedex, France) (Figs. 1b, c and 2b). The suture is interlocked after every stitch to ensure flat suturing. A Carpentier—Edwards classic tricuspid annuloplasty ring (Edwards Lifesciences, Irvine, CA) is then implanted (Figs. 1d and 2c). The ring is sized by measuring the pericardial patch and a size which is slightly smaller than the patch is selected.
Fig. 1. Operative pictures demonstrating tricuspid leaflet augmentation: (a) detaching the anterior leaflet from the tricuspid annulus, (b) sewing the pericardial patch on to the detached anterior leaflet, (c) the pericardial patch sewn on to the detached anterior leaflet and the annulus, (d) the completed repair with ring annuloplasty.

Fig. 2. Schematic diagrams demonstrating tricuspid leaflet augmentation: (a) anterior leaflet detached from the tricuspid annulus; (b) autologous pericardial patch sewn onto the tricuspid annulus and the detached anterior leaflet; (c) ring annuloplasty implanted; (d) augmented anterior leaflet with the pericardial patch as the main body of the leaflet and the native leaflet as the coaptation surface. AL, anterior leaflet; PL, posterior leaflet; SL, septal leaflet.
3. Results

We have used this repair technique in 15 patients, aged from 21 years to 77 years, with severe functional TR and a tethering height greater than 8 mm with no leaflet coaptation. All patients were in NYHA class III or IV. The aetiology of the TR included secondary to left sided heart valve disease, dilated cardiomyopathy and post-heart transplantation. All patients had no TR at the end of the operation and a coaptation length of at least 5 mm was achieved in all cases. The tethering height remained unchanged with increased coaptation occurring within the RV. Six to 20 months follow-up is available on five patients all of whom were in NYHA class I or II and no one had greater than trace TR.

4. Discussion

Functional TR occurs secondary to annular dilatation and leaflet tethering from RV dilatation and dysfunction, with RV eccentricity and raised pulmonary artery pressures as contributing factors [1,2,5]. In most cases, annular dilatation is the main mechanism of functional TR and we have previously reported excellent results with only a 2% recurrence rate following tricuspid ring annuloplasty for this [2]. However, our series did not include patients with severe TR or severe leaflet tethering where a recurrence rate of 15—30% has been reported [4,6]. It has long been recognised that ring annuloplasty is unlikely to successfully treat severe leaflet tethering in TR and several repair techniques have been suggested for these cases including suture bicuspidization of the tricuspid valve and the clover technique [7,8]. However, these repair techniques further increase leaflet tension and restrict leaflet motion and do not relieve the tethering effects of the dilated RV; important factors responsible for recurrent TR following ring annuloplasty [3].

The technique described in this paper attempts to overcome the tethering effects of the dilated RV by enlarging the anterior tricuspid leaflet, and hence its surface of coaptation, and bringing the coaptation zone down into the RV. The use of an autologous pericardial patch to enlarge the anterior tricuspid leaflet effectively increases the surface of coaptation by threefold and allows leaflet coaptation to take place within the RV at the level of the tethered septal and posterior leaflets, while maintaining leaflet mobility. This effectively compensates for severe leaflet tethering as leaflet coaptation is achieved with reduced leaflet tension. The use of an annuloplasty ring remains essential as tricuspid annular dilatation is almost always present. We now routinely perform this repair technique for severe TR if severe leaflet tethering is demonstrated by echocardiography (tethering height greater than 8 mm). The technique is easy to perform and cost-effective. Early results are promising and long-term follow-up is awaited.

References