Dynamic RING + STRING for ischemic mitral regurgitation: Papillary muscle repositioning and modification of the septal–lateral diameter in the loaded beating heart under echocardiographic guidance

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Video clip is available online.

Ischemic mitral regurgitation (MR) involves annular dilatation in all cases. Some patients, however, also exhibit severe leaflet tethering due to papillary muscle displacement. Leaflet tethering is the strongest predictor of repair failure in up to 30% of patients treated by undersized ring annuloplasty (RING). These failures emphasize the need for subvalvular strategies.

Several adjunctive techniques have been proposed, but only 3 techniques have received clinical acceptance. Borger and associates¹ reported initial results of cutting second-order chordae. The impact of this technique on left ventricular systolic function, however, has been discussed controversially. Leaflet extension has been performed successfully in a case series by de Varennes and associates.² We³ have reported a technique (RING + STRING) that allows repositioning of the posterior papillary muscle under transesophageal echocardiographic (TEE) guidance. Even though midterm results with this technique have been encouraging,³ we have been looking for further improvement. Reduction of the septal–lateral diameter has been the key to reduction of ischemic MR in the experimental setting.⁴ This observation has been the basis for the use of aggressively undersized complete rings used clinically. Recently, however, Magne and colleagues⁵ documented functional mitral stenosis with associated pulmonary hypertension and reduced functional capacity as result of aggressive undersizing, the equivalent of patient–prosthesis mismatch in mitral valve repair.

FIGURE 1. Dynamic annuloplasty device (MiCardia, Irvine, Calif) with detachable activation leads. Activation by radiofrequency allows deformation of the nitinol-based ring device in the septal–lateral dimension.

We were able to demonstrate that correction of the altered subvalvular geometry allows successful repair with concomitant implantation of only moderately undersized partial ring implants. We further hypothesized that an optimal repair would include normal-sized ring implants, avoiding mismatch once the repair includes correction of the altered subvalvular geometry.

In the present investigation, we report our experience with combining a dynamic RING (DYANA; MiCardia, Irvine, Calif) with STRING. DYANA (Figure 1) is a nitinol-based dynamic complete annuloplasty device that can be deformed by activation with radiofrequency, allowing further reduction of the septal–lateral diameter after implantation in the loaded beating heart.

CLINICAL SUMMARY

A 70-year-old woman (159 cm, 72 kg, body surface area 1.8 m²) had had recurrent episodes of decompensated heart failure. Echocardiography revealed severe MR (Video 1) with severe leaflet tethering (tenting height 14 mm) and associated pulmonary hypertension (right ventricular systolic pressure, 50 mm Hg). Left ventricular function was impaired (ejection fraction, 37%) with

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posterolateral/inferior akinesia. Coronary angiography demonstrated a 95% stenosis in the midportion of the right coronary artery. Concomitant diseases were arterial hypertension and chronic renal failure (creatinine, 2.1 mg/dL).

Approval for the use of the novel device was granted by our local ethics committee. After median sternotomy the patient was placed on cardiopulmonary bypass with the use of aortic and bicaval cannulation. Under cardioplegic arrest, the mitral valve was exposed via a transseptal approach. A 32-mm device was chosen according to the determined intertrigonal distance. The activation wires were exteriorized, and the right internal thoracic artery was anastomosed to the distal right coronary artery.

After ring implantation, a horizontal aortotomy was performed and the posterior papillary muscle was exposed through the aortic valve. A double-armed Teflon pledget-supported 3–0 polytetrafluoroethylene suture was passed through the head of the posterior papillary muscle and then exteriorized through the aortomitral continuity.³ During termination of cardiopulmonary bypass, residual MR (Video 2) was seen. The polytetrafluoroethylene suture was tied under TEE guidance in the loaded beating heart and the degree of MR was improved accordingly (Video 3). After termination of cardiopulmonary bypass, the DYANA device was activated by radiofrequency (8.0 W, 30 sec) via transatrial wires (Video 4) and residual MR was eliminated (Video 5). After completion of the activation process, the wires were detached and pulled through the atriotomy.

Follow-up echocardiography 6 months after the operation documented a competent mitral valve. Functional capacity was improved (New York Heart Association class II).

DISCUSSION

The combined repair approach using RING + STRING allows for successful mitral valve repair for ischemic MR

in the high-risk subpopulation of patients with severe leaflet tethering.³ We routinely use papillary muscle repositioning if tenting height (ie, orthogonal distance between the annular plane and the coaptation point) as surrogate of leaflet tethering exceeds 10 mm. This technique corrects the altered subvalvular geometry by repositioning of the posterior papillary muscle under TEE guidance in the loaded beating heart.

In the current case, further improvement of residual MR was achieved by postprocedural reduction of septal–lateral diameter in the loaded beating heart under TEE guidance by using a dynamic annuloplasty device. This nitinol-based ring implant can be actively deformed by 3 to 4 mm in the septal–lateral dimension. Optimizing this crucial distance under TEE guidance avoids patient–RING mismatch due to aggressive downsizing.

The dynamic annuloplasty ring in the present investigation was activated intraoperatively. The activation wires were removed under direct vision with the chest open. Ultimately, it would be desirable to have a device that would allow further modification of the septal–lateral diameter months after surgery if recurrent MR were detected.

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