Quick but effective surgery for functional mitral regurgitation secondary to aortic valve disease

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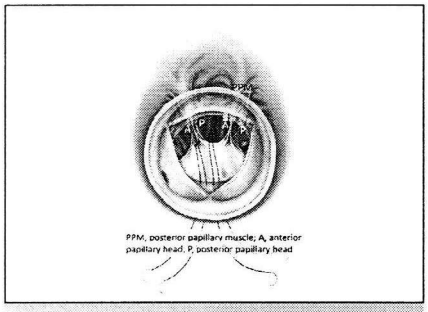


A novel surgery for secondary functional MR.

Central Message

We developed a surgery for functional MR secondary to aortic valvulopathy. The procedure can fix 2 valves by spending time for 1. Its clinical and physiologic benefits seem promising.

See Editorial Commentary page 278.

Video clip is available online.

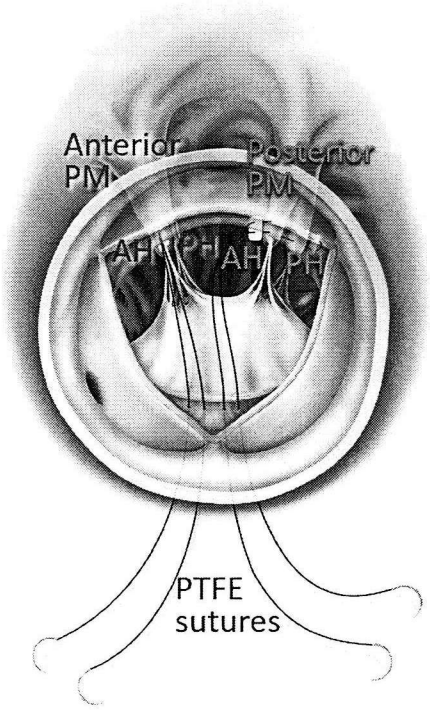


FIGURE 1. Modified relocation of PMs. Two papillary heads were connected by the PTFE suture in each PM, and the suture was externalized via subaortic curtain. The illustration of the posterior PM heads shows how to place a stitch to the 2 heads to connect them. *PM*, Papillary muscle; *AH*, anterior head; *PH*, posterior head; *PTFE*, polytetrafluoroethylene.

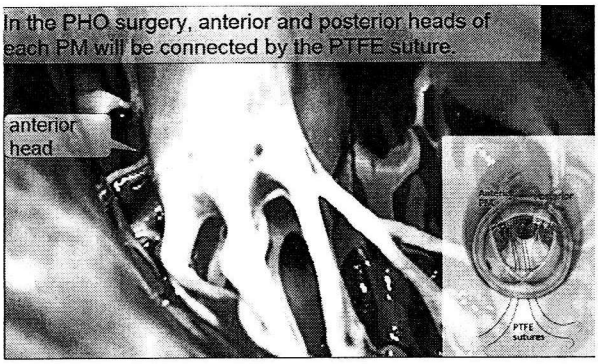
Severe aortic valve disease often causes secondary dilated cardiomyopathy and functional mitral regurgitation (MR). Aortic valve replacement alone may result in residual or recurrent MR.[1,2] Double valve replacement is associated with a high rate of mortality, especially in patients with poor left ventricular (LV) function.[2] In patients with mitral tethering, recurrent MR may occur after mitral annuloplasty.[3]

We have reported mitral valve repair with physiologic relocation of both anterior and posterior papillary heads of each papillary muscle (PM) to the mid-anterior annulus (papillary heads optimization [PHO]) to alleviate tethering of both the anterior leaflet (AL) and the posterior leaflet,[4] a modification of Kron's relocation. We applied this in all procedures via the aortic valve orifice (ie, often no need to open/close left atrium or annuloplasty) by introducing Langer's concept.[5]

PATIENTS AND METHODS

Of 47 patients who underwent PHO surgery for functional MR between 2010 and 2016, 18 who had the dilated cardiomyopathy secondary to aortic valve disease and 14 who did not have annuloplasty were reviewed. We selected PHO when the patient had significant mitral tethering and when the patient had both anterior and posterior heads in each PM (approved by Institutional Review Board NHC20130109). When the patient had a severely dilated annulus, annuloplasty was added and the patients were not included in the analysis.

Patients' age was 72 ± 10 years (mean ± 1 standard deviation); there were 8 men. Ten patients had aortic regurgitation, and 4 patients had stenosis. Preoperatively, the patients' New York Heart Association



VIDEO 1. *AR*, Aortic regurgitation; *Dd*, diastolic diameter; *DOE*, dyspnea on effort; *EF*, ejection fraction; *FMR*, functional mitral regurgitation; *LVA*, left ventricular aneurysm; *MAP*, mitral annuloplasty; *MR*, mitral regurgitation; *NCC*, noncoronary cusp; *NYHA*, New York Heart Association; *PHO*, papillary heads optimization; *PM*, papillary muscle; *PTFE*, polytetrafluoroethylene; *RCC*, right coronary cusp; *SVR*, surgical ventricular restoration; *TR*, tricuspid regurgitation. Video available at: http://www.jtcvsonline.org/article/S0022-5223(16)31034-0/addons.

functional class was 3.5 ± 0.7. Echocardiography revealed an LV diastolic diameter of 60.2 ± 9.8 mm, LV ejection fraction of 31.0% ± 14.3%, MR degree of 3.5 ± 0.7, and estimated right ventricular pressure of 49.3 ± 13.8 mm Hg. Preoperative tethering height of the mitral valve was 9.7 ± 1.1 mm. Paired *t* test was used for statistical analysis.

During the operation, after an aortotomy, all cusps were excised, allowing exposure of both PMs and the AL by using a long-blade retractor. A 4-0 Teflon-pledgeted polytetrafluoroethylene (PTFE) suture was used to connect the posterior and anterior heads in each PM, because the posterior head supports the chordae for the posterior leaflet and anterior head for AL. The PTFE suture was then passed through the subaortic curtain toward the outside of the heart and left untied for a while (Figure 1 and Video 1). Then, the aortic valve procedure was completed. After terminating the cardiopulmonary bypass, the PTFE relocation sutures were pulled/relaxed and tied under transesophageal echocardiography guidance when the tethering and the MR was zero or minimal.

RESULTS

In the operation, all patients had aortic valve procedures; 10 bioprostheses, 2 valve repairs, 1 root reimplantation, and 1 Bentall procedure. Concomitant procedures were 3 tricuspid annuloplasties and 2 ascending/arch replacements. All patients had an uneventful recovery, except for 1 patient, an 86-year-old woman with mesenteric emboli due to shaggy aorta 2 weeks postoperatively.

Postoperative echocardiography revealed an LV diastolic diameter of 53.1 ± 10.6 mm ($P = .006$ vs preoperatively), LV ejection fraction of 37.4% ± 16.2% (P = not significant, .10), degree of MR of 0.8 ± 0.6 ($P < .001$), and estimated right ventricular pressure of 32.1 ± 13.0 mm Hg ($P = .017$). Postoperative tethering height of the mitral valve was 4.6 ± 1.1 mm ($P < .001$).

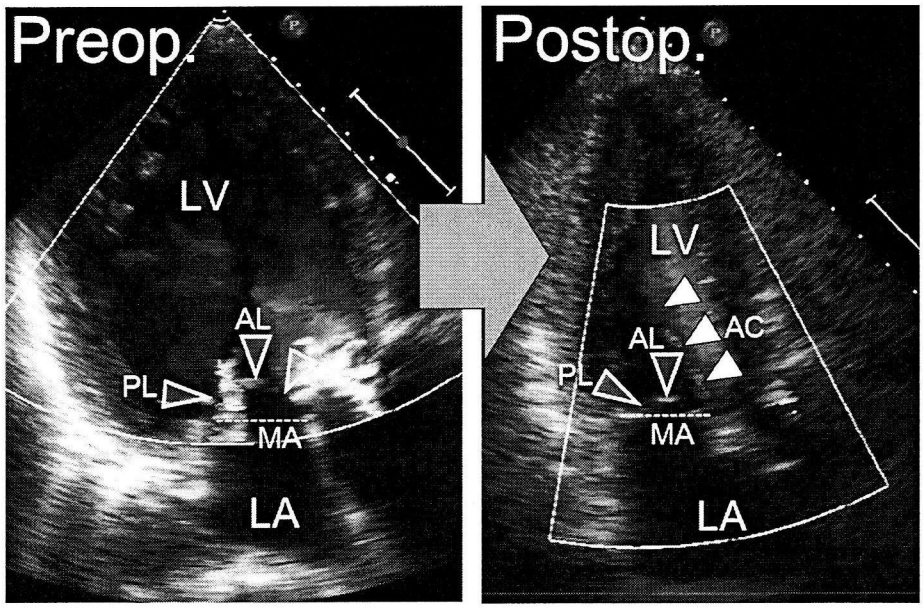


FIGURE 2. Echocardiography of a representative patient. A 64-year-old woman underwent the Bentall procedures and PHO relocation of the PMs via an aortic orifice. One year after the surgery, leaflets tethering, functional MR, and LV dilatation/sphericalization disappeared. Note that the patient did not receive mitral annuloplasty or left atriotomy. *White triangular markers* show artificial chordae for relocation. *LV*, Left ventricle; *AL*, anterior leaflet; *PL*, posterior leaflet; *MA*, mitral annulus; *LA*, left atrium; *AC*, artificial chordae.

Among 8 patients with more than 12 months of follow-up, there was 1 late death; 1 patient, a 71-year-old man with chronic hemodialysis, died suddenly on day 60. At 1010 ± 577 days after the surgery, LV diastolic diameter was 46.0 ± 8.1 mm ($P = .070$), LV ejection fraction was 60.4% ± 2.1% ($P = .003$), and MR degree was 1.5 ± 0.6 ($P < .035$). Echocardiography of a representative patient is shown in Figure 2.

DISCUSSION

In case of severe aortic valve disease with dilated cardiomyopathy and moderate functional MR, the management of MR remains controversial.[1-3] We tried to perform effective *double* valve treatment by spending time for a *single* valve.

To do so, we applied the PHO[5] method through an aortotomy to decrease the ischemic pump time; we saved approximately 40 minutes of ischemic time. We applied the method by attaching individual resuspension chorda to each PM because the patients had global LV dilatation/dysfunction and the anterior PM was dislocated.

So far, our procedure seems beneficial for those with functional MR and significant tethering secondary to aortic valvulopathy and those with a mitral annulus that is not overly dilated. Under this condition, we saved a significant amount of time. Moreover, it took less than 10 minutes to perform the PHO procedure via the aortic orifice. The procedure has another merit: accurate and effective tension control of the relocation sutures under the monitoring of transesophageal echocardiography with an off-pump beating condition.

CONCLUSIONS

The relocation method described may be one answer to the dilemma of treating functional MR secondary to aortic valvulopathy. It is in part ventricular treatment and may have a physiologic impact[5] rather than valvular treatment, such as the M-clip. Midterm results are encouraging, and further investigation is warranted.

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