Původní sdělení | Original research article

A second look at autopericardial mitral annuloplasty

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ARTICLE INFO

Article history:
Submitted: 13. 12. 2019
Accepted:. 9. 1. 2020
Available online: 10. 2. 2020

Klíčová slova:
Autoperikard
Mitrální valvuloplastika
Postižení mitrální chlopně
Protetický prstenec

SOUHRN

Cíl: Srovnat totální anuloplastiku s použitím perikardu (pericardial annuloplasty, PeMA) s totální anuloplastikou s použitím protetického prstence (prosthetic annuloplasty, PrMA) z hlediska trvanlivosti v léčbě degenerativní, ischemické i neischemické funkční mitrální regurgitace (MR).
Metody: Zpětně jsme zkontrolovali prospektivně shromažďované údaje 280 pacientů, u nichž byla v letech 2008 až 2015 po valvuloplastice provedena buď PeMA (50,4 %), nebo PrMA (s použitím anuloplastických prstenců Carpentier-Edwards Physio; 49,6 %). Mezi kombinované výkony patřily: 40× CABG (PeMA – 18, PrMA – 22); 13× ablace spolu s odstraněním ouška levé síně (PeMA – 8, PrMA – 5); 7× plastika mitrální chlopně (PeMA – 2, PrMA – 5); 9× uzávěr defektu septa síní (PeMA – 3, PrMA – 6).
Výsledky: Třicetidenní mortalita činila 0,4 %. Průměrná délka sledování skončila v 95,7 % případů po 83,4 ± 13,0 měsících. Výkony byly v sedmiletém horizontu srovnatelné: nulová nutnost reoperace a recidiva MR = 2+/3+ (PeMA 96,3 %; PrMA 96,4 %; *p* = 0,914); nepřítomnost komplikací (PeMA 86,5 %; PrMA 89,2 %; *p* = 0,174); přežití (PeMA 96,5 %; PrMA 97,8 %; *p* = 0,238). Celkové sedmileté přežití dosáhlo hodnoty 97,1 %. Podle multivariační analýzy byly vysoký věk a ischemická choroba srdeční = 2+/3+ (*p* = 0,027; HR = 1,131, resp. *p* = 0,030; HR = 2,002) významnými prediktory reoperace a recidivy MR i nezávislými predikčními faktory kratšího přežití (*p* = 0,029; HR = 4,251, resp. *p* = 0,040; HR = 1,135). V multivariační analýze vysoká hodnota ejekční frakce levé komory negativně korelovala s nižším rizikem reoperace a recidivy MR = 2+/3+ (*p* = 0,006; HR = 0,786) a příznivější délkou přežití (*p* = 0,013; HR = 0,718).
Závěry: Při dobře provedené valvuloplastice může mít perikardiální prstenec stejnou trvanlivost jako prstenec Physio a při použití dokonalejších metod fixace může být trvanlivost i delší. Pokud se týče ceny, představuje perikardiální prstenec lepší volbu, protože nestojí nic, zatímco cena prstence Physio je přibližně 600 USD. Protetické prstence nejsou vždy spojeny s rozvojem endokarditidy, tromboembolie, kalcifikace chlopně ani hemolytickou anémií.

ABSTRACT

Objective: To compare total pericardial mitral annuloplasty (PeMA) and total prosthetic mitral annuloplasty (PrMA) in terms of durability in the treatment of degenerative, ischemic functional and non-ischemic functional mitral regurgitation (MR).
Methods: We retrospectively reviewed prospectively collected data of 280 patients who received either PeMA (50.4%) or PrMA (with Carpentier-Edwards Physio rings; 49.6%) after valvuloplasty between 2008 and 2015. Combined procedures included: 40 CABG (PeMA – 18, PrMA – 22); 13 ablations with left atrial appendectomy (PrMA – 8, PrMA – 5); 7 tricuspid valve repairs (PeMA – 2, PrMA – 5); 9 closures of atrial septal defect (PeMA – 3, PrMA – 6).
Results: Thirty-day mortality was 0.4%. Mean follow-up was 95.7% complete at 83.4 ± 13.0 months. The procedures were comparable in terms of 7 years: Freedom from reoperation and recurrent MR = 2+/3+ (PeMA – 96.3%; PrMA – 96.4%; *p* = 0.914); freedom from complications (PeMA – 86.5%; PrMA – 89.2%; *p* = 0.174); survival (PeMA – 96.5%; PrMA – 97.8%; *p* = 0.238). Overall 7-year survival was 97.1%. Old-age and concomitant CAD were significant predictors of reoperation and recurrent MR = 2+/3+ (*p* = 0.027; HR = 1.131 and *p* = 0.030; HR = 2.002 respectively) and independent predictive factors for poor survival (*p* = 0.029; HR = 4.251 and *p* = 0.040; HR = 1.135 respectively) by multivariate analysis. High preoperative LVEF was independently related to a lower risk of reoperation and recurrence of MR = 2+/3+ (*p* = 0.006; HR = 0.786) and better survival (*p* = 0.013; HR = 0.718) by multivariate analysis.
Conclusions: With a reliable valvuloplasty, pericardial ring can be as durable as Physio ring and possibly surpass it with better methods of fixation. Cost-wise, pericardial ring is a better choice as it's free whilst Physio ring costs about $600. Prosthetic rings are not always associated with endocarditis, thromboembolism, valve calcification or hemolytic anemia.

Keywords:
Autopericardium
Mitral valve failure
Mitral valve repair
Prosthetic ring

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DOI: 10.33678/cor.2020.003

Please cite this article as: Sidiki AI, Faybushevich AG, Lishchuk AN. A second look at autopericardial mitral annuloplasty. Cor Vasa 2020;62:37–43.

Introduction

Treating mitral regurgitation (MR) has evolved since its inception about six decades ago. Surgical techniques have gone from valve repair to valve replacement, back to repair and now shifting towards percutaneous procedures. The quest for an optimal treatment in terms of durability, accessibility and cost-effectiveness has led to this evolution. Mitral valve (MV) reconstruction has largely replaced replacement as the standard method of treating MV insufficiency. The superiority of repair over replacement in terms of operative mortality, late survival, freedom from thromboembolic accidents, endocarditis, recurrent MR and re-operation is associated with the preservation of the valve structures in the reconstructive process (which are usually excised in replacement procedures).[1–3] Performing annuloplasty after leaflets or sub-valvular apparatus reconstruction ensures repair durability by remodeling and stabilizing the annulus. Despite significant gains in prosthetic-ring technology, such rings restrict valve dynamics especially the posterior leaflet and, in most cases, transform the anatomical bicuspid valve into a functional monocuspid valve. An ideal annuloplasty ring should restore the size and shape of the native annulus, prevent further annular dilatation and provide functional annular support. Despite conflicting opinions on the suitability of autopericardium as a ring material, it appears closest to an ideal ring if treated and used properly. The purpose of this study was to compare the durability of pericardial and prosthetic mitral annuloplasties (PeMA and PrMA) as isolated or adjunct procedures to valvuloplasty.

Materials and methods

We retrospectively reviewed prospectively collected data of 280 patients who received valvuloplasty (with or PeMA or PrMA) for MV insufficiency in three departments of our cardiac center from January 2008 to December 2015. Consent of all patients was obtained prior to surgery. MR was degenerative, ischemic or non-ischemic functional (annulus dilatation). Patients had received either one of the two annuloplasty techniques. Exclusion criteria were: concomitant aortic disease that required surgery, myocardial aneurysm, previous cardiac surgery, significant MV stenosis, infective endocarditis or rheumatic heart disease. Associated significant coronary artery disease (CAD), congenital atrial septal defect and atrial fibrillation (AF) were not exclusion criteria. Degenerative disease was the predominant etiology and was present in 225 (80.4%) patients. The indications for the operation were based on the severity of the MR (94% had MR ≥ 3+) rather than on NYHA functional class (88.9% were in class II or III).

Patients' assessment

Medical charts of all patients who met the inclusion criteria were reviewed. A structured database was created with demographic, preoperative and postoperative clinical and examinations data. Preoperatively, all patients had coronary angiography, transthoracic echocardiography (TTE) and in some cases, transesophageal echocardiography (TEE) to confirm diagnosis. Intraoperatively, TEE was routinely performed to assess the repair outcome. TTE was performed at follow-up.

Surgical procedure

In all cases, a complete median sternotomy was performed. For repair with PeMA, a 3 × 10 cm strip of pericardium was cut, cleaned of fatty tissue, washed with normal saline and treated with 0.62% glutaraldehyde for 15 minutes. The edges of the strip were sewn together inside-out (inner surface on the outside) with continuous sutures over a slender and tubular instrument using Prolene 6/0. Cardiopulmonary bypass with moderate hypothermia (28–32 °C) was instituted after standard aortic and bicaval cannulation. Intermittent antegrade cold blood cardioplegia was used to provide myocardial protection. An interatrial approach or left atriotomy were performed to access the MV. Standard insufflation of CO_2 was instituted with a flow of 2 L/min into the operative field. The valve was visually inspected to determine the possibility of a repair. For a valve-sparing procedure, the leaflets had to be mobile with no significant prolapse and judged as salvageable by the operating surgeon. A sizer was used to measure the commissure-commissure distance or the anterior mitral leaflet height for ring-size selection. In PrMA, a fitting Carpentier-Edwards Physio ring was chosen. For PeMA, the pericardial ring was cut to a fitting size. Valve repair depended on the pathology: leaflet resection for degenerative MR, edge-to-edge repair for MR with ruptured chordae/papillary muscle and isolated annuloplasty for non-ischemic (annulus dilatation) MR. Next, interrupted non-pledgeted mattress (12–14) sutures of Ethibond 2/0 were placed along the annulus 4–5 mm in width and 1–2 mm apart from the previous suture pair (Fig. 1). The sutures were then passed through the (prosthetic/pericardial) ring. The ring was lowered on to the valve, the necessary adjustments to the annulus made to ensure optimal leaflet coaptation, all the sutures tied and cut off. Tissue compression by the ring resulted in a ring size matching the size and form of the anterior leaflet.

Saline test was performed and the apposition of the leaflets checked for good coaptation. The atria were closed;

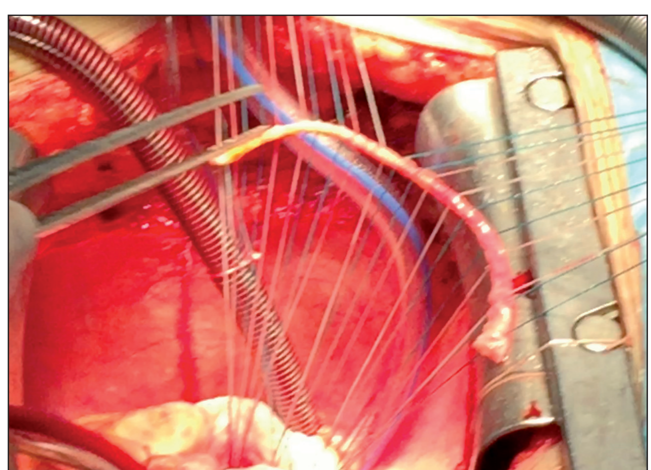

Fig. 1 – Pericardial ring is sewn onto the mitral annulus.

the heart filled with blood and allowed to beat. Then a TEE was performed. If the correction was adequate and reliable, the patient was weaned off cardiopulmonary bypass and decannulation started. If residual regurgitation was non-trivial, indications for valve re-repair or replacement was determined. Total operative time was prolonged in PeMA (PeMA – 205 ± 29; PrMA – 170 ± 32 minutes; $p = 0.042$) due to pericardial ring preparation. However, cardiopulmonary bypass and aortic cross-clamp times were similar and averaged to 98 ± 30 and 65 ± 13 minutes respectively.

Postoperative outcomes and follow-up

Postoperative complications were based on the current guidelines.[4] All patients had TTE at discharge and yearly. Patients or their cardiologist were contacted by phone or e-mail for information pertaining to the quality of life (QoL). The cause of death was determined by hospital charts, autopsy reports or from family physician. A cardiovascular death was considered to be death due to postoperative myocardial infarction, congestive heart failure, arrhythmia or acute endocarditis.

Echocardiography evaluation

TTE was by a Philips ie33 Matrix and TEE by Philips CX50 Ultrasound Systems. The volumetric method was used to calculate LV ejection fraction.[5] Other parameters obtained included transmitral pressure gradient, MV opening area as estimated by the pressure half-time method, degree of MR, annulus diameter in 4-chamber view, and septolateral dimension during diastole, as well as LV end-diastolic and end-systolic diameters, LV mass and mass index. Functional and segmental MV analyses were carried out by intraoperative TEE. The risk of systolic anterior motion was estimated on the basis of mitro-aortic angle and the ratio of annulus diameter to the anterior mitral leaflet's length.[6] TEE was repeated at the end of repair to assess the grade of residual MR and evaluate the occurrence of systolic anterior motion.[7] Parameters were measured three times to obtain a mean value. Severity of regurgitation was classified as trivial (1+), mild (2+), moderate (3+), or severe (4+) and was assessed in a semiquantitative manner by means of color Doppler flow mapping.

Data analysis

Statistical analysis of the data was performed with IBM SPSS Statistics version 23. Categorical variables were compared between groups by χ^2 test for independence or Fisher's exact test when necessary. Normality test was performed using Kolmogorov–Smirnov test. When the distribution of continuous variables was normal, Student T-test was used for comparison, otherwise, a non-parametric Mann–Whitney test was used. Group data were summarized by mean and standard deviation. Confidence limits of percentages were computed by means of a quadratic approximation to binomial distribution and continuity correction. Kaplan–Meier analysis was used to estimate the overall survival and freedom from reoperation and MR = 2+/3+.[7] Log-rank test was used to compare unadjusted overall group survival and freedom from reoperation and MR = 2+/3+ relative to baseline characteristics. Evaluation of multivariate relationships of potential predictive factors for late death, for reoperation and MR = 2+/3+ was by multivariable Cox regression analysis. Comorbidities such as arterial hypertension and type 2 diabetes mellitus that could be predictive of late death were well controlled in all enrolled patients and so they were not tested in the multivariate Cox analysis. Condi-

Table 1 – Preoperative variables

	PeMA	PrMA	*p* value
Age, years	69.6 ± 8.8	72.8 ± 9.5	0.101
Sex			
Male	104	109	0.429
Female	37	29	
NYHA class (%)			
Class I	8 (2.9)	6 (2.1)	
Class II	64 (22.9)	51 (18.2)	
Class III	59 (21.1)	75 (26.9)	
Class IV	11 (3.9)	6 (2.3)	
CAD (%)	18 (6.4)	22 (7.9)	0.281
AF (%)	8 (2.9)	5 (1.9)	0.286
ASD	3 (1.1)	6 (2.1)	0.001
LVEF (%)	47.9 ± 6.8	49.2 ± 8.4	0.151
LVM (g)	329.4 ± 84.4	314.2 ± 84.0	0.275
LVEDD (mm)	56.9 ± 6.2	56.7 ± 7.6	0.586
LVESD (mm)	43.1 ± 6.7	42.3 ± 8.2	0.335
MAD (mm)	34.4 ± 1.7	38.0 ± 2.7	0.001

AF – atrial fibrillation; ASD – atrial septal defect; CAD – coronary artery disease; LVEDD – left ventricular end diastolic diameter; LVEF – left ventricular ejection fraction; LVESD – left ventricular end systolic diameter; LVM – left ventricular mass; MAD – mitral annulus diameter.

Table 2 – Etiology of MV insufficiency. Valvuloplasty

Etiology of MVF	Total	PeMA	PrMA	*p value*
dMVD	225 (80.4%)	110	115	0.249
ifMVD	40 (14.3%)	22	18	0.363
non-ifMVD	15 (5.4%)	09	06	0.546
Valvuloplasty				
Resection	225 (80.4%)	110	115	0.249
EtE	10 (3.6%)	06	04	0.222
No valvuloplasty	45 (16.1%)	25	20	0.264

dMVD – degenerative mitral valve disease; EtE – Edge-to-Edge repair; ifMVD – ischemic functional mitral valve disease; non-ifMVD – non-ischemic functional mitral valve disease.

Table 3 – Postoperative data

Complications	PeMA	PrMA	*p* value
Mortality	5 (1.8%)	3 (1.1%)	0.222
SAM + LVOTO	3 (1.1%)	11(3.9%)	0.018
AF	6 (2.1%)	5 (1.8%)	0.526
MVR	2 (0.7%)	3 (1.1%)	0.537
MR = 2+/3+	7 (2.5%)	7 (2.5%)	0.928
MVS	5 (1.8%)	2 (0.7%)	0.165

AF – atrial fibrillation; MR – mitral regurgitation; MVR – mitral valve replacement; MVS – mitral valve stenosis; SAM + LVOTO – systolic anterior motion with left ventricular outflow tract obstruction.

tions such as chronic obstructive pulmonary disease, renal failure were not common among patients. Variables with a univariate p value ≤ 0.1 or those of known biological significance but failing to meet the critical α level were submitted for consideration to multivariable Cox analysis. A stepwise technique was used to enter the selected variables in the analysis.

Results

Preoperative and postoperative data

Of the 280 patients who received valvuloplasty, 141 (50.4%) had PeMA and 139 (49.6%) underwent PrMA. The two groups had similar demographics, preoperative clinical status and preoperative echocardiographic parameters except concomitance of atrial septal defect and annulus diameter ($p = 0.001$) (Table 1). Forty patients (14.3%; PeMA – 18, PrMA – 22) had combined CABG with no difference between the groups ($p = 0.281$). Seven patients (2.5%; PeMA – 2, PrMA – 5) had simultaneous tricuspid valve repair and thirteen patients (4.6 %; PeMA – 8, PrMA – 5) received treatment for AF with no difference between the groups ($p = 0.286$). Nine patients (3.2%; PeMA – 3, PrMA – 6) had repair of congenital atrial septal defect.

The two groups were similar in terms of the etiology of MV failure and technique of valvuloplasty (leaflet resection was most common) (Table 2).

Complications of the repair were similar in both groups except for systolic anterior motion and left ventricular outflow tract obstruction (systolic anterior motion and LV outflow tract obstruction [SAM + LVOTO]; transaortic pressure gradient $\leq$ 30 mmHg; $p = 0.018$) which was more frequent in PrMA (especially in patients with degenerative disease). With volume substitution and cessation of inotropic management, this resolved within a 3-month period. Mitral valve stenosis (transvalvular gradient 5–10 mmHg) was recorded in seven patients (2.5%; PeMA – 5, PrMA – 2) who had edge-to-edge repair. There were eight deaths (2.9%; PeMA – 5, PrMA – 3) in post-operative follow-up. Two (0.7%) cases of repair failure in PeMA and three (1.1%) in PrMA that required valve replacement were recorded. There were 26 instances of post-operative AF which mostly resolved with antiarrhythmic therapy or electrical cardioversion. Among these patients, six (2.1%) in PeMA and five (1.8%) in PrMA developed permanent AF at post-operative follow-up. Two cases were *de novo* permanent AF whilst nine were relapse cases (Table 3). Eleven cases of transient ischemic attacks were recorded before discharge. All resolved without focal neurological symptoms.

Follow-up data

Follow-up of 30-day survivors was 95.7% complete at 83.4 ± 13.0 months. All deaths occurred after postoperative day 30. No patient was lost on follow-up.

Durability of the repair

All repair failures (with MR >3+) that required valve replacement were procedure-related (dehiscence of annuloplasty sutures). One repair failure in PeMA was de-

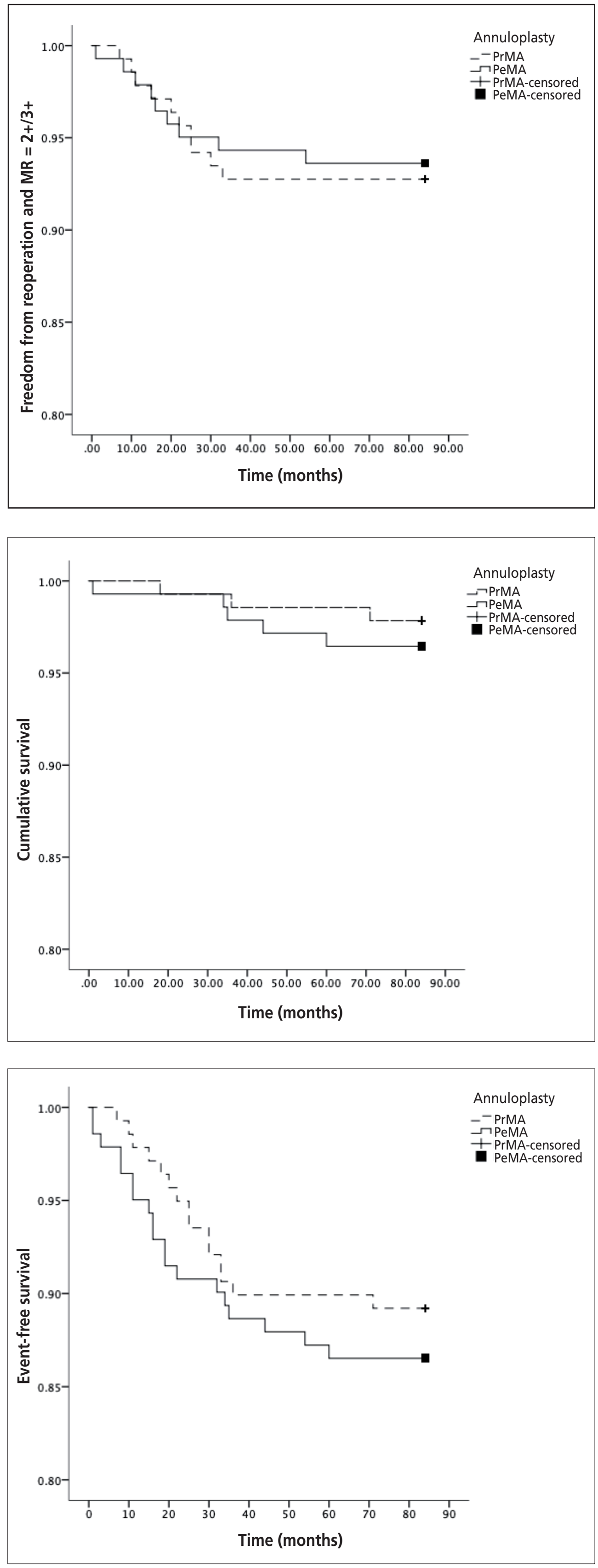

Fig. 2 – (A) Freedom from reoperation and MR = 2+/3+. $p = 0.914$. (B) Cumulative survival. $p = 0.238$. (C) Event-free survival (freedom from death, reoperation or MR = 2+/3+, endocarditis, thromboembolism, stroke, hemorrhage and AMI). $p = 0.174$.

Table 4 – Univariate and multivariate Cox analysis

Analysis	Hazard ratio	CL 95%	*p* value
For reoperation and MR = 2+/3+			
Univariate analysis			
Older age	1.225	1.14–1.33	<0.001
Significant CAD	2.035	0.01–4.00	<0.001
Higher LVEF	0.693	0.61–0.78	<0.010
Multivariate analysis			
Old age	1.131	1.01–1.26	0.027
Significant CAD	2.002	0.01–2.06	0.030
High LVEF	0.768	0.64–0.93	0.006
For survival			
Univariate analysis			
Older age	1.182	1.06–1.32	<0.010
Significant CAD	4.251	0.01–3.75	0.033
High LVEF	0.718	0.58–0.88	0.020
Multivariate analysis			
Older age	1.135	0.99–1.30	0.040
Significant CAD	5.200	0.01–3.98	0.029
Higher LVEF	0.837	0.66–1.06	0.013

CAD – coronary artery disease; LVEF – left ventricular ejection fraction.

termined at 19 months of follow-up and replaced whilst the other was determined on intra-operative TEE due to paravalvular regurgitation and also replaced on a second pump-run. Three repair failures in PrMA were diagnosed on follow-up TTE at 22, 25 and 30 months. Replacement was performed in all. During re-sternotomy in all cases, there was no evidence of ring calcification or degeneration. At follow-up, recurrent MR = 2+/3+ was recorded in 14 (5%; PeMA – 7, PrMA – 7; $p = 0.526$) patients.

Recurrent regurgitation in PrMA, was due to anterior leaflet prolapse or degenerative disease progression whereas in PeMA, it was associated with poor leaflet coaptation. These patients (with MR = 2+/3+) responded well to medical management (with NYHA Class = 1/2). Hence, there was no indication for redo surgery. The rest of the patients had trivial recurrent MR with no sign of worsening. Freedom from reoperation was 98.2% at 7 years (PeMA – 99.2%, PrMA – 99.1%; $p = 0.546$). Seven-year freedom from reoperation and recurrent MR = +2/+3 was similar: 96.3% in PeMA and 96.4.% in PrMA ($p = 0.914$) (Fig. 2A). Significant multivariate predictors of reoperation and recurrent MR = 2+/3+ were old age (≤70 years) and concomitant CAD. High preoperative LV ejection fraction (≥45) was independently related to a lower risk of reoperation and recurrent MR = 2+/3+, by multivariate analysis (Table 4).

Late survival

All deaths were cardiovascular-related and occurred in patients who had received CABG. They died of low cardiac output syndrome (with preoperative LV ejection-fraction ≤40 and NYHA Class ≥ 3). Seven-year overall survival was 97.1% (PeMA – 96.5%; PrMA – 97.8%; $p = 0.238$), as depicted in Fig. 2B. By multivariate analysis high preoperative LV ejection fraction (≥45%) was independently related to better survival. Significant CAD and old age (≤70 years) were independent predictive factors for poor survival by univariate and multivariate analysis respectively (Table 4).

Other outcomes

There was significant difference between the preoperative and postoperative overall NYHA Class (3.5 ± 0.5 and 1.5 ± 0.5 respectively; $p < 0.001$) with a mean improvement of 2.0 NYHA Class (CL95%: 1.9–2.1 NYHA Class). Improvement in terms of symptoms and QoL was observed in almost all 30-day survivors. Comparing preoperative and postoperative TEE, there was a significant increase in overall LV ejection fraction (mean difference= 2.7% – CL95%: 2.3–3.1%; $p = 0.008$). Postoperative LV end-diastolic diameter was smaller than preoperative LV end-diastolic diameter (mean difference= 5 mm – CL95%: 3.7–6.3 mm; $p < 0.001$) and so was LV end-systolic diameter (mean difference = 2.6 mm – CL95%: 2.1–3.1 mm; $p < 0.005$). Overall annulus diameter was significantly smaller postoperatively ($p < 0.001$).

At follow-up, eight patients were re-hospitalized for non-cardiac related problems: two with gastrointestinal disease, one due to upper respiratory tract infection and five with endocrinological problems. There was no reported case of hemorrhage, thromboembolism, stroke or acute myocardial infarction at follow-up. Seven-year event-free survival was 87.9% with no difference between the groups (PeMA – 86.5%, PrMA – 89.2%, $p = 0.174$) (Fig. 2C).

Discussion

Annuloplasty is an integral part of all valvuloplasty procedures. A ring/band remodels and stabilizes the annulus to ensure repair durability.[8,9] Most rings prevent progression of valve area enlargement[10] whilst transforming the anatomical bicuspid MV into a functional monocuspid valve with restriction of posterior leaflet movement. An analysis from the Brigham and Women's Hospital concluded that without ring implantation, five-year freedom from post-repair progression of myxomatous MV disease is only 67% ± 12%.[11] It's shown in animal models that without annuloplasty in edge-to-edge repair, the systolic stress on the leaflets is high leading to procedure-related failures.[12] Cohan and associates also reported a high risk of recurrent MR after repair for degenerative disease without annuloplasty.[13] Ring implantation helps the MV to bear the tension on the leaflet edges and also shields the repair sutures from enormous stress.[14] According to Carpentier, an annuloplasty ring is needed to restore the size and shape of the native annulus, prevent further annular dilatation and provide functional annular support. This is where the use of auto-pericardium comes into place.

Annuloplasty with pericardial tissue was introduced by Slati et al.[15] There are diverging opinions about its suitability for annulus reinforcement.[15–19] Some studies reported PeMA to be superior to PrMA in terms of preserving annulus physiological dynamics. Bevilacqua et al. compared posterior PeMA to posterior PrMA in patients with degenerative MR (with/without CAD). The 30-day mortality and recurrent high-grade MR were similar whilst 5-year freedom from re-operation and recurrent MR[20] was better in PrMA. In this study, at seven years of follow-up, the two techniques were comparable with respect to the above events. As shown in this study and others, transient SAM + LVOTO is a common finding in PrMA[21] for degenerative disease. This could be due to inadequate leaflet resection or inadequate ring size. Even though the engineering of the physio ring allows annulus dynamics, if it is small for the annulus, it will cause anterior displacement of the annulus further increasing the subvalvular tethering and leading to a reduction of the valve opening.[22]

Contrarily to the report by Obarski et al. that saline test is associated with air embolization to the right coronary artery and post-repair acute myocardial infarction,[23] we did not experience any of such complications. There was also no incident of circumflex coronary artery injury by sutures to the annulus which some studies have associated with an anomalous course of the artery.[24] Unlike previous similar studies, in this study we performed complete annuloplasty in all cases (with only rings). At reoperation in both groups, there was no evidence of ring calcification, pannus or thrombus formation over the rings (pericardial and physio). All repair failures were procedure-related. Unlike some previous studies[25,26], this study has not identified PeMA as independent risk factor of repair-failure and reoperation. We found the seven-year durability of both techniques to be comparable. It is our opinion that glutaraldehyde-treated pericardium is durable enough to provide a stable reinforcement of the mitral annuloplasty if the valvuloplasty is adequately performed. We expect a continuous reduction of LV end-diastolic diameter for subsequent years as the myocardium remodels.[26] PeMA maintains the physiological, non-planar configuration of annulus and enhances valvular-ventricular interaction due to the softness of pericardium and its ability to offer a good annular plication. Though not confirmed in this study, reports have indicated that PeMA enhances LV function and annular motion ensuring a more effective valve-orifice area at diastole (in exercise).[27,28]

Even though the moderate size of the study and narrow inclusion criteria can limit the value of the outcome, the results show that PeMA is comparable to PrMA and hence, it can be its alternative. In contrast to Gillinov et al.,[29,30] it's our opinion that a carefully performed valvuloplasty with PeMA provides "a measured plication" with good leaflet coaptation. The fact that autopericardium is absolutely free (whereas the Carpentier-Edwards Physio costs $600) makes PeMA even more attractive. Doubts about the durability of PeMA can be put to rest with better methods of treating autopericardium to be more resilient to degeneration and calcification. Of great interest is the number of adults who live with unnoticed congenital heart defects. In this study, we repaired nine congenital atrial septal defects with left to right shunting. These defects were detected incidentally on TTE. A decade or two ago, cardiac ultrasound was unavailable to most of the general public and so it's highly recommended for the elderly even during routine medical examination.

Late survival

The negative prognostic factor of old age and associated CAD, positive prognostic factor of high preoperative LV ejection fraction on freedom from reoperation and late survival respectively confirm the recommendations for early surgical intervention in order to improve the long-term outcome of repair.

Limitations of the study

Maybe, the results of this study would have been different had prosthetic-ring selection been based on pathology (Carpentier–Edwards Physio II ring for degenerative MR, Geoform-ring for non-ischemic functional MR and IMR ETlogix for ischemic-functional MR) or if only patients with a common valve disease were included in the study. The follow-up time could be short and the study population not large enough to reach a conclusive assessment of the two techniques.

Conclusions

When valvuloplasty is performed reliably, PeMA can be as durable as PrMA but cheaper as the ring is free (but prosthetic ring costs about $600). The use of a prosthetic ring is not necessarily associated with endocarditis, thromboembolism, valve calcification or hemolytic anemia. Larger prospective and randomized studies and longer follow-up times are needed to confirm these results. Eventhough we currently do not perform PeMA, it's our opinion that with a more efficient method of autopericardial fixation, PeMA can be superior to PrMA.

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