Papillary muscle relocation and mitral annuloplasty in ischemic mitral valve regurgitation: Midterm results

Khalil Fattouch, MD, PhD,[a] Sebastiano Castrovinci, MD,[b] Giacomo Murana, MD,[b] Pietro Dioguardi, MD,[a] Francesco Guccione, MD,[a] Giuseppe Nasso, MD,[c] and Giuseppe Speziale, MD[c]

Objectives: The surgical approach for ischemic mitral regurgitation remains unclear. Many studies are in favor of adding the subvalvular procedure to mitral annuloplasty to reduce recurrent mitral regurgitation. This study reports the clinical and echocardiographic outcomes of papillary muscle relocation combined with mitral annuloplasty.

Methods: From 2003, 115 patients with severe ischemic mitral regurgitation who underwent papillary muscle relocation plus nonrestrictive mitral annuloplasty and coronary artery bypass grafting were retrospective analyzed. Patients' mean age was 52 ± 12.8 years, New York Heart Association class III or IV was 71%, and preoperative left ventricular ejection fraction was 43% ± 6%. The study end points were New York Heart Association functional class, reversal in left ventricle remodeling, reduction of mean tenting area and mean coaptation depth, freedom from cardiac-related deaths and events, and freedom from recurrent mitral regurgitation. Follow-up data were obtained in all patients and were 100% complete. Mean follow-up was 45 ± 6 months.

Results: Five-year freedom from cardiac-related death and events was 91.3% ± 1.6% and 84% ± 2.2%, respectively. Recurrent mitral regurgitation more than moderate occurred in 3 patients (2.7%). Reversal in left ventricular remodeling, measured by a change in the end-diastolic and systolic diameter, was observed in our patients ($P < .05$). The postoperative mean tenting area and mean coaptation depth were 1.1 ± 0.2 cm^2 and 0.5 ± 0.2 cm, respectively; 95% of the patients were in New York Heart Association functional class I and II.

Conclusions: In patients with ischemic mitral regurgitation, papillary muscle relocation plus nonrestrictive mitral annuloplasty promotes a significant reversal in left ventricular remodeling, with a considerable decrease in tenting area and coaptation depth. Our approach is a durable method to reduce the recurrence of mitral insufficiency. (J Thorac Cardiovasc Surg 2014;148:1947-50)

ACD

In the era of mitral valve reconstruction, the surgical approach for ischemic mitral regurgitation (IMR) remains an open issue.[1,2] Many surgeons prefer restrictive mitral valve annuloplasty (R-MA), whereas others prefer mitral valve replacement with subvalvular apparatus preservation to avoid postoperative mitral regurgitation (MR).[3-8] The incidence of recurrent MR after isolated R-MA was 5% to 20% in several reports.[9,10] On the other hand, many authors have advocated postinfarction ventricular remodeling as the key issue in the development of IMR and suggest adding a subvalvular apparatus procedure to annuloplasty to reduce the risk of recurrent mitral valve insufficiency.[11-13] This study reports the midterm results of the clinical and echocardiographic outcomes of papillary muscle (PPM) relocation in conjunction with nonrestrictive mitral annuloplasty (NR-MA) in IMR.

MATERIALS AND METHODS

Patients

From March 2003, 115 patients (mean age, 52 ± 12.8 years; 56% were male) with severe IMR (effective regurgitant orifice area ≥20 mm^2, regurgitant volume ≥30 mL) who had PPM relocation in conjunction with NR-MA and coronary artery bypass grafting (CABG) were retrospectively analyzed. New York Heart Association (NYHA) class greater than II was present in 81 patients (71%), and mean left ventricular ejection fraction (LVEF) was 43% ± 6%. According to Carpentier's functional classification,[14] all patients with IMR presented restrictive systolic leaflets motion (Carpentier's type III b) and annular dilatation (Carpentier's type I). Mean coaptation depth and mean tenting area were 1.3 ± 0.1 cm and 3.2 ± 0.9 cm^2, respectively. MR was defined as ischemic when caused by coronary artery disease in patients who had a previous myocardial infarction 2 weeks or more before hospital admission for CABG and exhibited normal valve apparatus anatomy. Exclusion criteria were recent myocardial infarction (<15 days), PPM infarction causing its elongation or rupture, organic mitral valve lesions (rheumatic, infective, degenerative),

From the Department of Cardiovascular Surgery,[a] GVM Care and Research, Maria Eleonora Hospital, Palermo, Italy; Department of Cardiac Surgery,[b] University of Bologna, Bologna, Italy; and Department of Cardiovascular Surgery,[c] GVM Care and Research, Anthea Hospital, Bari, Italy.

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Address for reprints: Khalil Fattouch, MD, PhD, Department of Cardiovascular Surgery, GVM Care and Research, Maria Eleonora Hospital, Viale Regione Siciliana 1571, 90100 Palermo, Italy (E-mail: khalilfattouch@hotmail.com).

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CI = confidence interval
HR = hazard ratio
IMR = ischemic mitral regurgitation
LV = left ventricular
LVEF = left ventricular ejection fraction
MR = mitral regurgitation
NR-MA = nonrestrictive mitral annuloplasty
NYHA = New York Heart Association
PPM = papillary muscle
R-MA = restrictive mitral valve annuloplasty

previous cardiac surgery, and concomitant aortic valve surgery. Baseline patient characteristics are shown in Table 1.

End Points

The study end points were as follows: incidence of early mortality and outcomes, freedom from cardiac-related deaths and events, freedom from recurrent MR 2 or greater, NYHA functional class, reverse in left ventricular (LV) remodeling, evaluation of tenting area, and coaptation depth. A cardiac event was defined as the occurrence of at least 1 of the following: myocardial infarction, congestive heart failure, cardiac death, revascularization (CABG or percutaneous intervention), new onset of atrial fibrillation, redo operation on the mitral valve, worsening in NYHA functional class, recurrent MR grade of 2 or greater, and hospital readmission.

Surgical Technique

All patients underwent conventional multivessel CABG via a longitudinal median sternotomy under normothermic cardiopulmonary bypass with intermittent antegrade cold-blood cardioplegia. The bypass grafts used were the internal thoracic artery and the long saphenous vein in all patients. All distal anastomoses were performed during a single aortic crossclamping. The proximal graft anastomoses were performed during side-clamping (Table 1).

Mitral valve annuloplasty was performed using the Carpentier-Edwards Physio ring (Edwards Lifesciences, Irving, Calif) or the Saddle Rigid ring (St Jude Medical, Minneapolis, Minn). The ring size was determined according to the surface of the anterior leaflet. In regard to our nonrestrictive annuloplasty, we used the normal-sized ring, not the undersized. In patients who undergo PPM relocation, the use of a ring according to the anterior leaflet surface may be effective without having to risk an undersizing. Rings were inserted using deep horizontal U sutures and Ticron 2-0 stitches (Syneture, Norwalk, Conn).

Relocation of the PPMs was performed using a polytetrafluoroethylene suture (CV-4 Gore-Tex; WL Gore & Associates Inc, Flagstaff, Ariz) placed first at the head of each PPM and subsequently through the ipsilateral mitral annulus while the heart was arrested, according to the technique described by Kron and colleagues.[12] We relocate both PPMs to minimize the mitral valve tenting. In most cases, 1 head of the anterior PPM was relocated. On the other hand, among the 3 heads of the posterior PPM, we relocated the anterior and posterior heads. It is important to relocate both heads of the posterior PPM because from the anterior, one head arises from the chordae for the anterior leaflet responsible for the seagull sign and respective tenting, and from the posterior, one head arises from the chordae to the posterior leaflet (P2 and P3 scallops).[15]

All patients underwent postoperative transesophageal assessment of the LV and valve function. Mitral valve repair was considered successful if there was no or trivial residual MR and a coaptation surface of approximately 0.8 cm.

Follow-up

All patients were followed by our cardiologists at 6-month intervals. Preoperative and postoperative clinical status were determined according to the criteria of the NYHA functional class and the Canadian Cardiovascular Society for heart failure symptoms and angina, respectively. Clinical follow-up data were obtained in all patients and were 100% complete. Mean follow-up was 45 ± 6 months.

Statistical Analysis

The numeric values are expressed as mean ± standard deviation. The frequency ratios are given as percentages. LV end-diastolic and end-systolic diameters, and LVEF percentage were analyzed using the paired *t* test and Wilcoxon signed-rank test. Variables were put into a Cox regression model. Where appropriate, hazard ratios (HRs) are presented with 95% confidence intervals (CIs). Actuarial survival and other time-related events were analyzed with the Kaplan–Meier method. Log-rank test was used to compare statistical significance level. SPSS software (SPSS Inc, Chicago, Ill) was used.

RESULTS

Early Outcomes

Of the entire population, 4 patients (3.4%) died in-hospital. Causes of in-hospital death were low cardiac output in 2 patients, sepsis in 1 patient, and multiorgan failure in 1 patient. Intra-aortic balloon pump implantation was required to treat postoperative cardiogenic shock in 2 patients (1.7%). Renal failure requiring dialysis was present in 4 patients (3.4%). All data are shown in Table 2.

TABLE 1. Baseline and intraoperative data

Baseline	
Mean age (y)	52 ± 12.8
Male gender	65 (56%)
Diabetes mellitus	38 (33%)
COPD	12 (10.4%)
Hypertension	70 (60%)
Renal failure*	9 (7.8%)
Unstable angina	35 (30.4%)
CHF	44 (38%)
Atrial fibrillation	6 (5.2%)
NYHA >II	81 (71%)
euroSCORE	8.8 ± 2.6
LVEF	43 ± 6
LVEDD	58.8 ± 12
LVESD	48.1 ± 9
Mean tenting area	3.2 ± 0.9
Mean coaptation depth	1.3 ± 0.1
Intraoperative	
CPB time (min)	114 ± 20
Crossclamp time (min)	85 ± 10
Grafts/patient	2.8 ± 0.5

Values are mean ± standard deviation or number (%). *CHF*, Congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CPB*, cardiopulmonary bypass; *euroSCORE*, European System for Cardiac Operative Risk Evaluation; *LVEDD*, left ventricular end-diastolic diameter; *LVEF*, left ventricular ejection fraction; *LVESD*, left ventricular end-systolic diameter; *NYHA*, New York Heart Association.
*Serum creatinine greater than 1.5 mg/dL.