International Journal of Cardiology 204 (2016) 218–228

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Predictive factors of long-term results following valve repair in ischemic mitral valve prolapse

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ARTICLE INFO

Article history:
Received 27 September 2015
Received in revised form 17 November 2015
Accepted 22 November 2015
Available online 23 November 2015

Keywords:
Mitral valve
Prolapse
Ischemic mitral regurgitation
Functional mitral regurgitation
Surgery

ABSTRACT

Background: In patients with ischemic mitral regurgitation, leaflet prolapse requires an accurate evaluation since surgical approach depends on valvular and subvalvular characteristics. This study aims to describe a cohort of patients over a long-term follow up, analyzing survival, reoperation and predictive factors of surgical outcomes.
Methods and results: From March 1994 to June 2011, 75 patients with ischemic mitral regurgitation and leaflet prolapse underwent surgical myocardial revascularization and mitral valve repair (90.7%) or replacement (9.3%). Our cohort was followed up until April 2015, with a mean follow up of 7 ± 3 years.
Cardiac-related deaths occurred in 26 patients, with a mean survival of 114.2 months, including eight patients with in-hospital mortality. Reoperation was performed in 14 patients, due to valve repair failure. Twenty-six patients experienced moderate-to-severe mitral regurgitation. A preoperative LVEDD > 62 mm, LVESD > 52 mm, previous anteroseptal myocardial infarction, diffuse coronary artery disease, papillary anatomy type 1, partial rupture of the papillary muscle, A1-A2 scallop prolapse and postoperative mitral valve configuration (tenting area, tenting height, alfa-1 angle and alfa-2 angle) were identified as independent predictors of poor outcome. An index quantifying the stress on the annulus imparted by annuloplasty was elaborated and predicted endpoints.
Conclusion: Leaflet prolapse is an important entity in patients with ischemic mitral regurgitation, and its pathogenic mechanism mostly relies on papillary muscle lesion or elongation. Perioperative parameters describing geometric features of left ventricle, valvular and subvalvular components should be considered to provide a tailored approach for mitral valve repair, or to opt for immediate replacement in case of unfavorable geometry.

1. Introduction

Ischemic mitral prolapse (IMP) results from a papillary muscle (PM) injury consequent to myocardial infarction (MI) [1]. The actual incidence of IMP is about one-third among the patients undergoing surgery for ischemic mitral regurgitation (IMR). Nevertheless, it is difficult to be accurately evaluated, the recognition of prolapse might be difficult and can be easily overlooked in the clinical practice [2]. Acar et al. described the first case series in which a primary lesion of a PM was responsible for leaflet prolapse [2]. In the minority of cases, the prolapse associated to the necrosis of a restricted area of the myocardium adjacent to the PM, determining its abnormal traction and its dyssynchrony [2–4]. Localization of prolapse, anatomic features of the prolapsed leaflets and the subvalvular apparatus should be carefully evaluated as constituting the major determinants guiding the choice of the best surgical approach to be adopted, and defining patient's outcome [5,6].

Although, Smith et al. reported in a large randomized clinical trial that restrictive annuloplasty in moderate IMR does not provide better clinical outcomes when associated to myocardial revascularization [7] and these findings were confirmed by a systematic review of the current clinical evidences [8], the benefit of surgical correction of valve dysfunction in the context of IMR or IMP is still an argument of debate [9,10]. Also, the evidence that the presence of a mitral leaflet prolapse in IMR should represent an indication to surgery of the mitral valve (MV) in combination with CABG, has been reported [11].

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http://dx.doi.org/10.1016/j.ijcard.2015.11.137
0167-5273/

Considering the high prevalence of leaflet prolapse in IMR and the vivid debate currently existing on the best surgical approach to be used in severe IMR [12–15], the present study aims to describe patients scheduled for IMR surgery with a recognized mitral prolapse, and to evaluate the long-term follow up of this subpopulation. Perioperative, intraprocedural and echocardiographic parameters have been evaluated with the aim to individuate predictive factors of long-term outcomes of valve repair in IMP. The importance of the restoration of a normal configuration of the ventricle and valvular apparatus, triggered to consider the geometrical alteration imparted by annuloplasty and the stress on the mitral annulus, which was quantified using an index.

2. Methods

2.1. Patients and study protocol

From March 1994 to June 2011, a mitral prolapse has been identified in 75 out of 226 consecutive patients (33.2%) undergoing surgical correction of IMR associated with surgical myocardial revascularization. Option of MV repair was primarily assessed; MV replacement was performed if valve repair was not technically achievable or its intraoperative results were not satisfactory. The clinical criteria to assess the ischemic origin of mitral regurgitation consisted in a recent or past history of coronary disease with an evidence of ischemic damage of myocardial wall or PM. All patients had at least moderate mitral regurgitation; patients with typical myxomatous or rheumatic lesions on the MV were not included in the study cohort. We assessed and recorded the site of myocardial infarction, the morphology of the PM interested, the regional left ventricular (LV) wall injury, the surgical anatomy, as well as perioperative echocardiographic data. Preoperative and intraoperative characteristics are shown in Tables 1 and 2. Primary endpoint of the study was the evaluation of cardiac-related death in a mid-term follow up. All-cause mortality, freedom from reoperation and freedom from moderate-to-severe mitral regurgitation were secondary endpoints. Informed consent was obtained from all patients and the study was approved from our institutional ethical committee and review board.

Table 1
Patients' characteristics.

Patients	75	100.0%
Male sex	51	68.0%
Age (years)	63.3 ± 7.8	
< 50	4	5.3%
50–59	16	21.3%
60–69	38	50.7%
≥ 70	17	22.7%
NYHA class		
I	0	0.0%
II	17	22.7%
III	34	45.3%
IV	24	32.0%
CCS angina scale		
no angina	46	61.3%
grade III to IV	29	38.2%
Family history of cardiovascular disease	56	74.7%
Hypertension	46	61.3%
Dyslipidemia	28	37.3%
Chronic kidney disease	32	42.7%
Chronic obstructive pulmonary disease	11	14.7%
Diabetes	16	21.3%
Peripheral vascular disease	7	9.3%
Cerebrovascular disease	6	8.0%
Preoperative atrial fibrillation	8	10.7%
Cardiogenic shock	3	4.0%
Chronic kidney disease	8	10.6%
Serum creatinine (mg/dL)		
< 1.1	24	32.0%
1.1–1.3	19	25.3%
1.3–1.6	18	24.0%
≥ 1.7	14	18.7%
Blood urea nitrogen (mg/dL)		
< 17	23	30.6%
17–23	19	26.6%
23–29	17	22.6%
≥ 30	16	21.3%
Mitral regurgitation grade		
3	40	53.4%
4	35	46.6%

Table 2
Surgical data.

Coronary artery disease > 50%		
Left anterior descending artery	37	49.3%
Diagonal artery	27	34.6%
Circumflex artery	50	66.7%
Right coronary artery	53	70.7%
Number of diseased vessels		
Three-vessels disease	30	40.0%
Two-vessels disease	24	32.0%
One-vessel disease	21	28.0%
Urgent surgery	10	13.3%
Surgery within 60 days from acute myocardial infarction	44	58.6%
Mean number of grafts	2.1 ± 0.8	
Mitral valve replacement	7	9.3%
Mitral valve repair	68	90.7%
Leaflet procedures	31	41.3%
Commissuroplasty	21	28.0%
Quadrangular resection	10	13.3%
Subvalvular procedures	37	49.4%
Chordal transposition	26	34.7%
Neochordae implantation	11	14.7%
Annular procedure (annuloplasty)	68	90.7%
Carpentier Edwards rings (mean size 27.5 ± 0.9)	65	86.7%
Flexible Duran rings (mean size 30.0 ± 1.0)	3	4.0%
Classification of papillary muscle injury		
Antero-lateral papillary muscle lesion	15	20.0%
Necrosis of adjacent myocardium	10	13.3%
Postero-medial papillary muscle lesion	50	66.7%
Mean cardiopulmonary bypass time (min)	122.4 ± 14.8	
Mean aortic cross-clamp time (min)	100.7 ± 11.5	
In-hospital mortality	8	10.7%
Cardiac deaths (including in-hospital mortality)	26	34.7%
Cardiac deaths (without in-hospital mortality)	18	24.0%
All-cause mortality	30	40.0%
Reoperations	14	18.7%
Moderate-to-severe mitral regurgitation during follow up	26	34.7%

2.2. Surgical procedure and intraoperative findings

According to Carpentier classification, functional type II with structurally normal MV was the most frequent. In addition, cases of systolic restricted leaflet motion on the remaining leaflets (type III-b) and some degree of annular dilatation (functional type I) were also present highlighting an imbalance between tethering forces and closing forces in IMP [16]. The classification of ischemic MV prolapse on the basis of intraoperative finding was performed according to Jouan et al. [2].

MV repair was performed in 68 cases (90.7%) and valve replacement was required in seven cases (9.3%). Intraoperative observation revealed leaflet prolapse with structurally normal MV in all patients. Mechanisms of IMP, valve pathophysiology and features of PM lesions are shown in Tables 3 and 4 and distributions of IMP graphically represented in Fig. 1.

Seven patients had a MV replacement. Five patients presented with injury of the anterolateral PM had a total rupture while the other one showed a partial rupture. One patient, who manifested with injury of the posteromedial PM, had a partial rupture with an extensive prolapse of A3-PC-P3 scallops. MV repair techniques and operative procedures used are shown in Table 2; in all cases, a downsized annuloplasty was performed.

Concomitant CABG was performed in all patients. An internal thoracic artery was used in all patients with left anterior descending artery lesion. 56 patients (74.7%) received two mammary arteries for CABG.

2.3. Clinical and echocardiographic follow up

Patients were followed-up clinically and using echocardiography as part of the routine procedure until April 2015 and data reviewed until August 2015.

Postoperative transesophageal echocardiography was performed in all patients immediately after MV procedure to assess MV configuration. Transthoracic echocardiography was performed in all patients to assess freedom from recurrence of mitral regurgitation during follow up. Routine echocardiographic parameters along with specific measurement of tenting area (TA), tenting height (TH), alfa-1 and alfa-2 angles were taken [17]. Outpatient evaluations after 1, 6 and 12 months from surgery and thereafter annually were performed, and the last available follow-up has been considered. In case of death, a telephonic interview with one of patient's relatives was carried out. Death was considered of cardiac origin unless an underlying disease was previously known.

2.4. Statistical analysis

Continuous variables are expressed as mean and standard deviation. Categorical variables are expressed in number and percentages. Cut-offs were evaluated with receiver