The Heart Surgery Forum #2014-337
17 (4), 2014 [Epub August 2014]
doi: 10.1532/HSF98.2014337

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Surgical Strategy for Moderate Ischemic Mitral Valve Regurgitation: Repair or Ignore?

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ABSTRACT

Background: Ischemic heart disease is a significant complication of atherosclerosis. Myocardial infarction after the development of coronary artery disease can lead to a number of serious complications, including ischemic mitral regurgitation (IMR). Currently there is no consensus regarding the preferred therapeutic modality for moderately severe IMR. In this study, the postoperative outcome of concomitant coronary artery bypass (CABG) and mitral valve repair was compared with that of CABG alone in two groups of patients with moderately severe IMR.

Methods: A total of 84 patients who underwent operations for coronary artery disease and moderately severe IMR were included in the study. Preoperative demographic and clinical characteristics were recorded at the time of admission. The severity of mitral regurgitation was graded using transthoracic echocardiography and left ventriculography.

Results: Significant postoperative improvements were observed in ejection fraction and systolic diameter compared to preoperative values ($P = .006$ and $P = .020$ respectively, in the intervention group, $P = .001$ and $P = .001$ respectively, in the control group). The decrease in pulmonary artery pressure (PAP) was significant only in the intervention group ($P = .001$). There was a significantly marked reduction in the severity of IMR in the intervention group compared to control.

Conclusion: Surgical repair of the mitral valve in conjunction with CABG for moderately severe IMR appears to be more effective than isolated CABG for certain outcome parameters, including decreased severity of mitral regurgitation and decreased pulmonary artery pressure.

INTRODUCTION

Ischemic heart disease is one of the most significant complications of atherosclerosis. Myocardial infarction as a result of coronary artery disease may lead to further serious complications, such as ischemic mitral regurgitation (IMR). The reported prevalence of IMR in patients undergoing catheterization after MI ranges between 10.9% and 19.4% [Barzilai 1990]. Of patients undergoing coronary artery bypass (CABG) surgery, 4-5% were found to have IMR [Barzilai 1990; Wierup 2009].The co-existence of these two conditions increases the incidence of mortality and morbidity. The best surgical approach to treatment is a current topic of clinical research in heart surgery.

Generally, concomitant surgery aimed at correcting the abnormality in the mitral valve is preferred for grades 3 and 4 IMR, but in milder forms (ie, 1 and 2) CABG alone is considered sufficient to improve ventricular function. However, the appropriate treatment of moderately severe (grade 2, grade 2-3) IMR is currently disputed – some surgeons advocate for MV repair with CABG, while others believe that CABG alone is sufficient, with potential benefits of the additional intervention offset by increased risk of mortality [Barzilai 1990; Wierup 2009].

In this study, the postoperative outcome of concomitant CABG and mitral valve repair was compared with that of CABG alone in two groups of patients with moderately severe IMR and comparable preoperative demographic data and clinical characteristics.

MATERIALS AND METHODS

A total of 84 patients who underwent surgery for coronary artery disease and moderately severe ischemic mitral regurgitation between 2007 and 2010 at our cardiovascular surgery unit were included in the study. Of these, 45 underwent mitral repair with CABG and 39 had CABG alone. The decision for the type of surgery was at the discretion of the treating surgeon. At the time of admission preoperative demographics and clinical data were recorded. Mitral regurgitation was graded preoperatively by transthoracic and transesophageal echocardiography (TTE, TEE) (Vivid 7 Dimension, GE Medical Systems, Horten, Norway). Patients with confirmed mitral regurgitation underwent left ventriculography during coronary angiography and mitral regurgitation was quantitatively graded. Postoperative data collection was carried out at 18 months at our outpatient unit. Demographic data are shown in Table 1. Follow-up included a physical examination, medical history and TTE/TEEs by the same cardiologist.

Received March 5, 2014; received in revised form May 30, 2014; accepted June 18, 2014.

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ECHOCARDIOGRAPHIC AND ANGIOGRAPHIC EVALUATION

All patients were evaluated using the same echocardiography device (Vivid 7 Dimension, GE Medical Systems, Horten, Norway) and the following measurements were recorded:

- Left ventricle diastolic diameter (DD)
- LV systolic diameter (SD)
- Systolic pulmonary artery pressure (sPAP)
- Ejection fraction (EF)
- Grade of mitral regurgitation

The grading of mitral regurgitation was based on regurgitant jet area, width of vena contracta (VC-W) and proximal isovelocity surface area (PISA). Patients with mitral regurgitation as detected by echocardiography underwent left ventriculography during coronary angiography to quantitatively define the regurgitation. Left ventriculography was performed in a biplane 30° right and 60° left anterior oblique projection with 50 mL of iopamidol. The amount of radio-opaque material passing through the left atrium was graded from 1 to 4 as described by Sellers et al. [Sellers 1964]. The severity of IMR by echocardiography and angigography showed good correlation.

OPERATIVE TECHNIQUE

After induction of general anesthesia, a median sternotomy was performed and the left internal mammary artery and saphenous vein grafts prepared. The aorta was cannulated. Venous cannulation was a selective "L" shaped cannulation via the superior vena cava. Cardioplegia was infused antegrade from the ascending aorta and retrograde through the coronary sinus. In those patients with left ventricular dysfunction (EF < 50%), a recent MI (<1 month), or increased left ventricle diameter (LVD > 5.4 cm), warm blood cardioplegia was repeated every 20 minutes. Following the distal coronary anastomoses, a left atriotomy from Sondergaard's plane was carried out in the intervention group and the mitral valve evaluated. Mitral valvuloplasty and papillary muscle reposition techniques were performed as needed depending on the pathology of the valve, and all patients underwent a mitral annuloplasty with the St. Jude Medical rigid annuloplasty ring (St. Jude Medical, Inc., St. Paul, MN, USA). In those cases with wide left atrium, atrial size was reduced and then closed.

STATISTICAL ANALYSIS

Constant variables were shown as mean ± standard deviation. Categorical variables were presented as frequency percentages. Statistical differences between the intervention and control groups were investigated with *t*-test and Mann-Whitney *U* test for constant variables. Categorical data were evaluated with chi-square test. A *P* value less than .05 was considered statistically significant.

RESULTS

Preoperative patient characteristics were comparable in terms of age, gender, heart rhythm, diabetes, hypertension, chronic obstructive pulmonary disease (COPD), hyperlipidemia (HL), and chronic renal failure (CRF) between the two groups (Table 1). The two groups were also comparable with regard to preoperative echocardiographic and clinical data. The mean and standard deviations for echocardiographic and other clinical data are shown in Table 2. Except for diastolic diameter (DD) and pulmonary artery pressure (PAP), no difference was observed between the groups. As expected, differences in DD and PAP were more marked with worsening regurgitation.

Although the number of patients with moderately severe preoperative IMR was higher in the intervention group, the average severity of IMR was similar between the two groups (Table 3). Postoperatively, the average severity of IMR was significantly lower in the intervention group.

A comparison of preoperative and postoperative echocardiography data is presented in Table 4. A significant improvement postoperatively was observed in EF and SD compared to baseline in both groups (*P* = .006 and *P* = .020, respectively in the intervention group, *P* = .001 and *P* = .001, respectively in the control group). The postoperative decrease in PAP reached statistical significance only in the intervention group (PAP 38.55 ± 10.91 decreased to 31.90 ± 5.72, *P* = .001). No

Table 1. Preoperative Demographics of the Study Group

Demographics	Intervention group (n = 45)	Control Group (n = 39)	*P*
Age	61.67 ± 8.27	63.08 ± 8.00	.521
Gender			
Female	18(40%)	17(43.6%)	.739
Male	27(60%)	22(56.4%)	
Rhythm			
NSR	36(80.0%)	36(92.3%)	.108
AF	9(20.0%)	3(7.7%)	
Hypertension			
+	30(66.7%)	21(53.8%)	.230
-	15(33.3%)	18(46.2%)	
Hyperlipidemia			
+	18(40.0%)	15(38.5%)	.886
-	27(60.0%)	24(61.5%)	
Diabetes Mellitus			
+	14(31.2%)	10(25.6%)	.580
-	31(68.8%)	29(74.4%)	
Chronic Renal Failure			
+	3(6.7%)	6(15.4%)	.292
-	42(93.3%)	33(84.6%)	
Chronic Obstructive Pulmonary Disease			
+	30(66.7%)	18(46.2%)	.058
-	15(33.3%)	21(53.8%)	

Table 2. Preoperative and Postoperative Echocardiographic Parameters

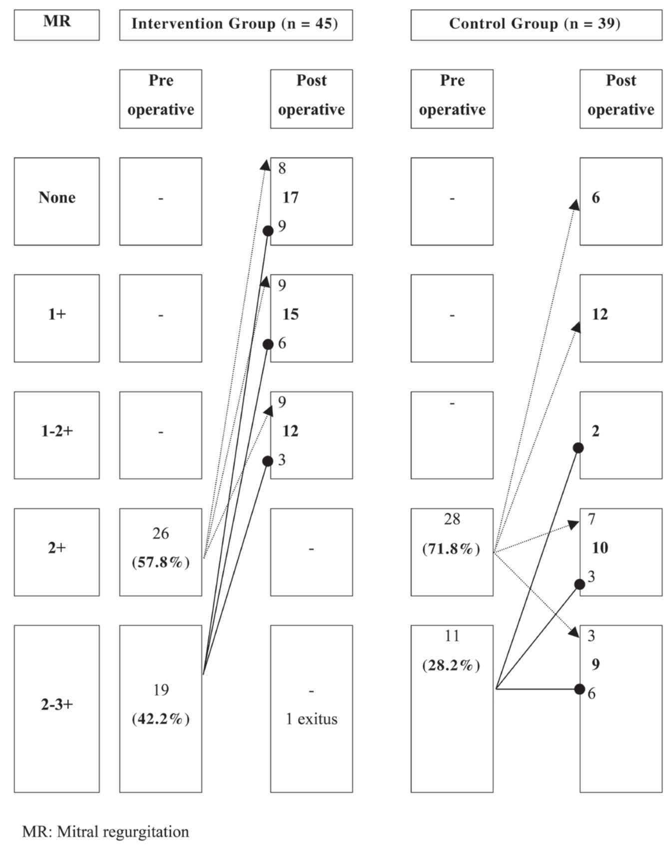
	Mean ± Standard Deviation	*P*
Preoperative Ejection Fraction		
Intervention	47.37 ± 10.38	.326
Control	50.46 ± 7.01	
Preoperative Diastolic Diameter		
Intervention	54.10 ± 5.80	.024*
Control	50.77 ± 4.81	
Preoperative Systolic Diameter		
Intervention	41.03 ± 6.65	.461
Control	39.88 ± 4.54	
Preoperative Pulmonary Artery Pressure		
Intervention	38.43 ± 10.74	.025*
Control	32.38 ± 14.83	
Postoperative Ejection Fraction		
Intervention	51.10 ± 11.03	.980
Control	53.38 ± 4.51	
Postoperative Diastolic Diameter		
Intervention	52.69 ± 6.25	.126
Control	50.23 ± 4.28	
Postoperative Systolic Diameter		
Intervention	37.83 ± 6.15	.806
Control	38.19 ± 4.57	
Postoperative PAP		
Intervention	31.90 ± 5.72	.246
Control	31.00 ± 13.47	

Table 3. Distribution of Mitral Valve Regurgitation Between Groups and Periods

	Mean ± Standard Deviation	*P*
Preoperative Mitral Regurgitation		
Intervention	2.20 ± 0.25	.183
Control	2.14 ± 0.23	
Postoperative Mitral Regurgitation		
Intervention	0.75 ± 0.63	.001
Control	1.47 ± 0.86	

significant differences were observed between the two groups in NYHA classes (2.38 ± 0.56 in the intervention and 2.08 ± 0.68 in the control group). Postoperatively, the average NYHA class showed a significant decrease in both groups.

The proportion of patients with grade 2 and grade 2-3 mitral regurgitation in the intervention group was 57.8% and 42.2%, respectively, with at least one grade improvement postoperatively. At 18 months follow-up, 37.7% of patients had no evidence of mitral regurgitation, and the maximum grade of IMR was 1-2 in the intervention group (26.6% of patients). No patients in this group had the same or worsened grade of IMR. Of the controls, 71.8% and 28.2% had grade 2 and grade 2-3 IMR preoperatively. Postoperatively, 58.9% had a reduction in the grade of IMR, the severity remained the same in 33.3%, and 7.7% had a 1 point improvement in severity (Figure).



Alterations in Mitral Regurgitation Following Surgery.

Multivariate analysis show no significant correlation between demographic and preoperative clinical data and the severity of IMR. Postoperatively, there was a significantly marked reduction in the severity of IMR in the intervention group compared to control. Similarly, PAP showed a significant reduction in the intervention group, while other echocardiography parameters and NYHA classes did not differ significantly between the groups (Table 5). There was no in-hospital mortality. During the follow-up period, an 82-year old patient died at 11 months due to pneumonia; this patient had concomitant morbidities which included: HL, HT, DM, and COPD. There was no cardiac mortality in either group.

DISCUSSION

Ischemic mitral regurgitation is a ventricular rather than a valvular disease, representing a complication of coronary

Table 4. Comparison of the Pre-postoperative Echocardiographic Parameters and New York Heart Association Functional Classes

	Intervention Group (n = 45)			Control Group (n = 39)		
	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*
Ejection fraction	47.45 ± 10.56	51.10 ± 11.03	.006	50.46 ± 7.01	53.38 ± 4.51	.001
Diastolic Diameter	53.97 ± 5.85	52.69 ± 6.25	.295	50.77 ± 4.81	50.23 ± 4.28	.157
Systolic Diameter	40.83 ± 6.67	37.83 ± 6.15	.020	39.88 ± 4.54	38.19 ± 4.57	.001
Pulmonary Artery Pressure	38.55 ± 10.91	31.90 ± 5.72	.001	32.38 ± 14.83	31.00 ± 13.47	.054
Mitral Regurgitation	2.20 ± 0.25	0.75 ± 0.63	.001	2.14 ± 0.23	1.47 ± 0.86	.001
New York Heart Association Class	2.38 ± 0.56	1.38 ± 0.49	.001	2.08 ± 0.68	1.39 ± 0.49	.001

artery disease and occurring as a result of complete or partial obstruction of one or more coronary arteries. Management of IMR is associated with significant challenges, and approaches for treatment of moderately severe IMR are particulary controversial.

Normal mitral valve function requires a functional mitral apparatus, and normal left ventricular function is dependent on a competent mitral valve. In the case of IMR, the co-existence of coronary artery disease and IMR results in a vicious cycle, further complicating the clinical picture. Despite normal anatomy, the valvular apparatus of IMR is dysfunctional due to partial or global ventricular dysfunction.

Ischemic MR is associated with higher surgical mortality and poorer long-term prognosis compared to structural MR, and also has higher recurrence rates following surgical repair [Lung 2003]. One of the major causes of this unfavorable prognosis is the existence of significant concomitant medical conditions in this group of patients [Bouchard 2001; Lung 2003]. In addition, the hibernation and ischemia that occur following deficient revascularization can contribute to unsatisfactory improvement in IMR following surgery. Despite this, some authors advocate mitral valve repair with CABG on the basis of the fact that rigid ring annuloplasty has been shown to be beneficial for most patients and that revascularization alone does not suffice for the restoration of valvular function [Duarte 1999; Aklog 2001; Gillinov 2001; Prifti 2001; Harris 2002; Mallidi 2004; Braun 2005; Kim 2005; Lam 2005]. In contrast, opponents of the surgery claim that the operative risks of the repair procedure far outweigh the benefits – that there will be no difference in survival even with successful repair, due to the nature of the disease itself [Ryden 2001; Ogus 2004; Wong 2005; Di Mauro 2006; Kang 2006]. However, several limitations, such as small sample size, mismatch between control and intervention groups, and inadequate study designs preclude a general consensus. Thus, in most situations treatment is individualized and left to the discretion of the surgeon or the policy of the clinic.

Table 5. Comparison of the Difference in Parameters Between the Two Groups

Parameter	*P*
ΔEjection Fraction	.799
ΔNew York Heart Association Class	.080
ΔDiastolic Diameter	.635
ΔSystolic Diameter	.460
ΔPulmonary Artery Pressure	.018
ΔMitral Regurgitation	.001

Postoperative assessments generally indicate more severe IMR and higher PAP in those undergoing CABG alone than in patients receiving both treatment modalities. In those patients, despite improvement in myocardial ischemia, mitral valve dysfunction continues to exist, requiring the use of diuretics and cardiac glycosides, and at later stages, antiarrhythmic medications, in addition to the anti-ischemic, antiplatelet and antihyperlipidemic drugs which are frequently given postoperatively. In the worst case scenario, a high risk redo surgery is required for worsening mitral regurgitation.

In the present study, all patients in the intervention group showed improvement in IMR postoperatively. In contrast, the severity of IMR remained same in the majority of control patients, with a worsening in three patients. These results lend support for the use of mitral repair in addition to CABG in these cases. The marked improvement in the severity of IMR and PAP in the intervention group can be expected to result in a long-term decrease in residual MR and pulmonary pathology. A reduced risk for arrhythmias, thromboembolic events and CHF can also be expected.

Follow-up assessments at 18 months showed no difference in cardiac mortality between the two groups. The only mortality in the intervention group was an 82-year old patient with severe concomitant and pulmonary morbidity. However, since a 6 to 12 month period is required for the recovery of ventricular function and morphology in these patients, a longer follow-up period might provide different data with respect to mortality. In this regard, data in the literature is not very revealing. Schroder et al. suggested that isolated CABG caused increased mortality in a group of patients with IMR [Schroder 2005]. Studies by both Mallidi (2004) and Lam

(2005) reported improvements in survival with valvular surgery in patients with moderately severe ischemic MR [Mallidi 2004; Lam 2005]. The reported in-hospital mortality in various studies on CABG plus mitral valve intervention ranges between 3% and 13% [Adams 2000; Schroder 2005; Wierup 2009]. However, it should be kept in mind that these studies have limitations that preclude drawing definite conclusions. The limitations of this study include a small sample size and absence of randomization.

The results of our study suggest that mitral valve and CABG repair in patients with moderately severe IMR may be a more effective treatment modality than CABG alone in terms of reduction in severity of IMR and PAP. Furthermore, these results were achieved without an increase in mortality or morbidity, which suggests that this approach may be a safe therapeutic modality in patients with IMR.

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