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Initial Report of Off-Pump Coronary Artery Bypass Surgery as Sole Therapy for Moderate Ischemic Mitral Regurgitation: Operative and Intermediate-Term Outcome

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ABSTRACT

Background: Patients undergoing on-pump coronary artery bypass surgery (CAB) with coexistent moderate ischemic mitral regurgitation (IMR) have a significant mortality rate compared to patients without MR. The mortality rate is elevated both perioperatively (0%-12% mortality), as well as over a 1- and 2-year postoperative period (15%-25%). It is thought that some patients are best served by off-pump CAB (OPCAB); however, outcomes have not been reported for such patients with coexistent moderate IMR.

Methods: We reviewed the independent database of patients undergoing OPCAB between 1995 and 2002 to find 989 patients, 17 (1.7%) of whom had moderate or moderately severe MR. Patients were contacted and clinical and echocardiographic data were obtained.

Results: The patient group consisted of 11 men and 6 women (age, 65±15 years). The study group had a PA pressure of 52 ± 14, creatinine of 1.6 ± 0.7, and left ventricular ejection fraction of 43 ± 18. Nine patients (53%) had advanced New York Heart Association (class III-IV) heart failure. Mortality rates perioperatively and at 1, 2, and 3 years were 0%, 6.25% (1/16), 12.5% (2/16), and 38% (4/8), respectively. At the time of this report, no patient had returned for a reparative procedure.

Conclusion: In patients felt to be best served by OPCAB with ischemic MR, operative and intermediate mortality rates are remarkably similar to those previously reported for on-pump series. These data underscore the continued need to understand which patients undergoing CAB require mitral valve problems to be addressed at the time of surgery.

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INTRODUCTION

Patients who require coronary bypass surgery and also have mitral regurgitation (MR) of even moderate degree have higher mortality rates than those without MR. [Grigioni 2001, Hamner 2003]. This finding has led to interest in the best treatment approach for these patients and often a lower threshold to add a mitral valve reparative procedure during surgery for patients undergoing coronary revascularization. The development of off-pump coronary artery bypass (OPCAB) has made it feasible for patients with neurologic or other high-risk features to undergo bypass surgery without the risks associated with cardiopulmonary bypass (CPB) [Puskas 2004]. Triage decisions, therefore, must be made to determine if a patient with moderate MR should undergo revascularization alone off or on CPB or on CPB with simultaneous repair. We evaluated our early experience with OPCAB in patients with moderate to moderately severe (2-3+) MR. We also compared these data to a previous series of similar patients undergoing on-pump CAB [Harris 2002].

METHODS

Study Group

Patients undergoing OPCAB at Abbott-Northwestern Hospital/Minneapolis Heart Institute between January 1995 and April 2002 (n = 989) were reviewed using an independently maintained computerized database, and patients with 2 to 3+ MR were identified. The grade of MR was based on the interpretation of the preoperative ventriculography or transthoracic echocardiogram. In cases of discrepant grading between the 2 exams, the greater severity was used for this study.

Surgical Technique

All procedures were performed via median sternotomy. Cell salvage was used in all cases. Exposure was obtained using deep pericardial sutures to present the heart, and the

Medtronic Octopus device (Medtronic, Fridley, MN, USA) was used for stabilization. Distal anastomoses were constructed using 7-0 and 8-0 monofilament suture and proximal anastomoses using 6-0 monofilament. Hemodynamic stability was maintained during the operative procedure using patient positioning, volume loading, and when indicated intermittent inotropic or pressor support.

Data Collection

Perioperative (hospital and 30-day) event data were collected prospectively. Late deaths were determined by review of hospital records and the social security death index. One patient was lost to long-term follow-up beyond 6 weeks. The mean follow-up interval was 3.1 ± 2.1 years. Patient telephone contact was performed both early and late (between August 2003 and April 2004).

In order to determine if patients undergoing OPCAB differed with respect to outcome from patients undergoing on-pump CAB, the study group data were compared to data from a large historical series of patients with similar degrees of MR, previously reported by one of the authors [Harris 2002].

Statistical Methods

Descriptive parameters are listed as the mean ± standard deviation. Comparisons were performed between the current series and a historic control using Fisher exact and *t* tests where appropriate. Survival curves were constructed using the Kaplan-Meier method. The groups were also compared using log-rank and Wilcoxon analyses. Cox regression analysis was used to determine which among selected risk factors could best explain mortality.

RESULTS

During the study interval, 989 patients underwent off-pump CAB. Seventeen patients had moderate (2+) (n = 12) or moderately severe (3+) MR, and 1 patient had severe (4+) MR. Because the goal of the study was to evaluate the outcome of patients with moderate MR, the patient with severe MR was excluded. The demographic variables of the study population are shown in Table 1. Of note, 9 (53%) patients had NYHA class III or IV heart failure symptoms.

Mortality, Residual MR, and Follow-up Data

The operative risk observed was 0% compared to the Society of Thoracic Surgeons predicted risk of 3.4%. Intermediate-term mortality was 6.25% (1/16) at 1 year, 12.5% (2/16) at 2 years, and 38% (4/8) at 3 years. In 9 patients undergoing postoperative echocardiograms at 183 ± 268 days, the mean grade of MR was less at the time of follow-up (1.7 ± 0.9) than it was preoperatively (2.3 ± 0.8), (P = .02).

Twelve of the surviving patients were available for intermediate-term telephone contact. At the time of this report, no patient had returned for reoperation. One patient has reported continued symptoms consistent with and 2 have been admitted with congestive heart failure. Three patients have undergone further procedures, including an angiogram (1), abdominal aortic aneurysm repair (1), and automatic implantable defibrillator placement (1).

Comparison to Historical Series

In order to put this series outcome in perspective, the outcome was compared to a large historical series of patients

Table 1. Comparison of the Off-Pump Study Population to Historical On-Pump Series*

	Off-Pump (N=17)	Historical On-Pump (N=142)	*P*	Matched† (N=17)	*P*
Age, y	65.5 ± 15.4	69 ± 10	NS	66 (14)	NS
Male sex	11 (64.7%)	76 (53.5%)	NS	17 (52.9%)	NS
Creatinine <1.6 mg/dL	10 (59%)	105 (79%)	.075	10 (59%)	NS
Hypertension	14 (82%)	108 (76%)	NS	14 (82%)	NS
Diabetes	5 (29%)	65 (46%)	NS	5 (29%)	NS
CVD	0	29 (20%)	0.04	0	NS
Obesity	3 (18%)	6 (4.2%)	0.057	2 (12%)	NS
COPD	4 (24%)	22 (15%)	NS	3 (18%)	NS
NYHA class III or IV	9 (53%)	21 (15%)	.0001	4 (24%)	NS
Previous MI	5 (29%)	113 (80%)	.001	14 (82%)	.001
Ventricular arrhythmia	1 (6.3%)	20 (14%)	NS	2 (12%)	NS
Emergent status	0	25 (18%)	.076	5 (29%)	.044
Previous CAB	2 (12%)	20 (14%)	NS	0	NS
PA pressure, mm Hg	47 ± 17 (n=14)	49 ± 17 (n=20)	NS	50 ± 33	NS
LVEDP (mm Hg)	18.8 ± 8.8 (n=11)	27.3 ± 8.5	0.002	25.1 (6.1)	0.044
LVEF	43.3 ± 17.8	38.7 ± 12.6	NS	0.420 (0.150)	NS
MR Grade 3	5 (29%)	16 (11%)	0.05	3 (18%)	NS

*Data are n (%) or mean ± SD. Patient data from historical series [Harris 2002] shown in Figures 1 and 2. CVD indicates history of cerebrovascular disease; COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Association; MI, myocardial infarction; CAB, coronary artery bypass surgery; PA, pulmonary artery; LVEDP, left ventricular end diastolic pressure; LVEF, left ventricular ejection fraction; LIMA, left internal mammary artery; MR, mitral regurgitation.

†Matched patients from historical series [Harris 2002].

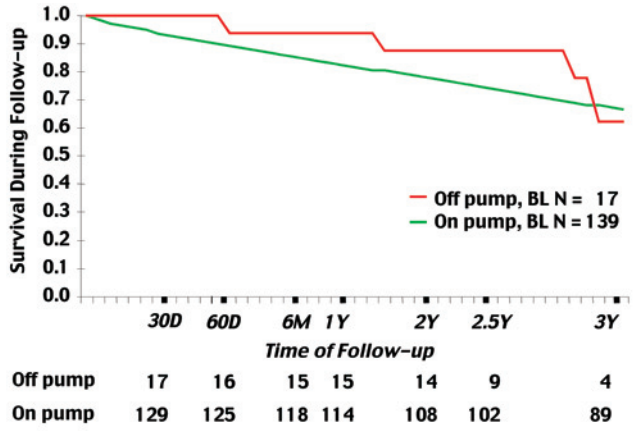

Figure 1. Kaplan Meier survival curve for current off-pump series compared to historical series of patients with moderate ischemic mitral regurgitation (MR) undergoing on-pump coronary artery bypass surgery [Harris 2002]. BL indicates baseline; D, days; M, months; Y, years.

with similar degrees of MR undergoing on-pump CAB (n = 142). The demographic variables of the current and historical series are displayed in Table 1. Patients were similar with respect to age, sex, creatinine, and diabetes. Patients in the historical series were more likely to have cerebrovascular disease (CVD), previous myocardial infarction, and higher left ventricular end diastolic pressure. They did, however, have a lower NYHA class and were less likely to have grade 3 MR. The survival rates for the current OPCAB series both perioperatively (100% versus 93%, P = NS) and at intermediate follow-up (2-year survival, 88% versus 79%, P = NS) were similar to the historical control series (Figure 1).

Although our study group was small, we also attempted to match the patients to a group within the historical series (Table 1) with similar clinical variables. Patients were selected on the basis of age, creatinine, diabetes, and CVD, the variables most predictive of mortality in the earlier series. The survival of the current series and the matched group was identical, as demonstrated in Figure 2. The combined series was evaluated for predictors of mortality using a multivariable Cox regression model and was dominated by established risk factors including creatinine (relative risk 3.0, P = .0001), diabetes (2.0, P = .0038), and CVD (2.2, P = .0048).

DISCUSSION

These data are the first to outline the early history of patients with 2 to 3+ MR undergoing OPCAB and show remarkably similar short- and intermediate-term survival compared to a larger series of patients undergoing revascularization on CPB. Furthermore, in this small series, revascularization alone was associated with an overall improvement in the degree of MR, and no patient required reoperation.

Data for several series of patients with moderate MR undergoing on-pump revascularization are shown in Table 2. Although differences exist in the baseline clinical variables, including the degree of MR between series, certain trends in mortality are demonstrated. It is often difficult to compare survival between series because of differences in comorbidities and the lack of systematic reporting of variables between series. Our patients show survival rates that are comparable to these earlier series. When we compared survival of the current series to our earlier series and when we matched the groups for relevant clinical variables, we found very similar outcomes.

Advanced heart failure class was an important predictor of suboptimal results in previous series evaluating revascularization alone [Arcidi 1998, Harris 2002]. When NYHA class was available in the series presented in Table 2, the incidence varied from 10% to 90% (data not shown), and it was 53% in the current series. The lack of uniform reporting across series makes comparisons between groups difficult. Further study with larger groups will be needed to determine the optimal approach for subgroups such as those with heart failure.

The critical question a clinician faces in patients with moderate MR is whether the addition of a reparative procedure to coronary bypass improves long-term outcome. Revascularization alone has been suggested to be an appropriate strategy for these patients [Arcidi 1988, Ryden 2001]. This report, as with other series, shows there may be heterogeneity in patients who may optimally be treated with OPCAB alone versus those who may require a simultaneous or staged reparative procedure. In some patients, ventricular remodeling post-CAB may lead to beneficial reduction in MR severity as shown in this study and by others [Christensen 1995]. Thus patients with comorbidities without advanced heart failure are often felt to be best served by revascularization alone [Arcidi 1988]. The current data support the supposition that OPCAB in these patients leads to a similar outcome, as previously shown for patients undergoing on-pump revascularization.

Off-pump surgery has been used with increasing frequency over the past 9 years. However, we are not aware of any previous data that have specifically addressed whether patients with moderate MR can undergo OPCAB. The data

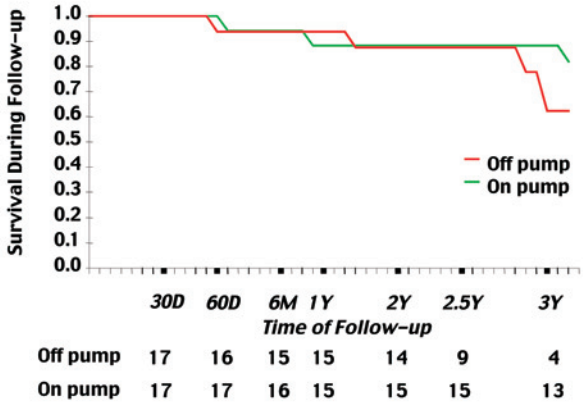

Figure 2. Survival curve of patients with moderate ischemic mitral regurgitation who underwent off-pump coronary artery bypass (CAB) and of a matched group of patients from a historical series who underwent on-pump CAB [Harris 2002].

Table 2. Historical Series Evaluating On-Pump Revascularization Alone as Treatment for Ischemic Mitral Regurgitation (MR)

Reference	No. of Patients	MR Severity	Mortality			
			30 Day	1 Year	2 Year	3-5 Year
[Connolly 1986]	85	1+- 3+	11%	NA	NA	31% (5)
[Hickey 1988]	94	Moderate-Severe	13%	NA	NA	NA
[Christensen 1995]	56	1+-3+	3.6%	5.4%	NA	NA
[Arcidi 1988]	58	Moderate	3.4%	NA	NA	19% (5)
[Czer 1996]	25	1+-3+	0%	NA	NA	42% (5)
[Harris 2002]	142	2-3+	9%	19%	22%	34%(3)
[Prifti 2001]	50	2-3+	12%	18%	28%	39% (3)
[Ryden 2001]	89	Moderate	4.5%	9%	NA	16% (3)
[Aklog 2001]	136	Moderate	2.9%	NA	NA	NA
[Tolis 2002]	49	1+-3+	2%	12%	NA	35% (3) 50% (5)
[Trichon 2003]	687	2+-4+	NA	16.7%	NA	26% (3) 36% (5)
[Mallidi 2004]	163	1-2+ MR	3.5%	9%	10%	11% (3) 13% (5)
[Paparella 2003]	167	2-3+	1.8%	NA	NA	18% (5)

presented here will need to be confirmed in larger series of patients with moderate MR undergoing OPCAB. Assuming similar results are obtained with future study, the acceptable early mortality shown with these data suggest that OPCAB could be combined with reparative procedures. Further investigation of new mitral valve approaches, such as Coapsys device implantation, which can be performed during the same operation as OPCAB, as well as staged OPCAB followed by percutaneous valve repair, are indicated [Fukamachi 2004]. Prospective studies will be needed to compare OPCAB alone with OPCAB in combination with new reparative techniques.

CONCLUSIONS

In patients needing multivessel revascularization, if the patient is felt to be best suited for OPCAB, these data show that patients can be treated with this approach and the result will be intermediate-term outcomes similar to those reported earlier with CAB on CPB. If it is deemed that the patient is best suited for mitral valve intervention and OPCAB, a simultaneous off-pump reparative procedure or a staged percutaneous reparative procedure can also be undertaken if the revascularization is known to be associated with acceptable risk.

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