

# Management of Patients Undergoing Coronary Artery Bypass Graft Surgery with Mild to Moderate Aortic Stenosis

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**Background and aim of the study:** The management of patients undergoing coronary artery bypass graft (CABG) surgery with mild to moderate aortic stenosis (AS) remains controversial. The study aim was to examine the outcome in patients with mild to moderate AS undergoing CABG.

**Methods:** A retrospective analysis was carried out of 200 patients with coronary artery disease requiring CABG and with a peak AS gradient <40 mmHg measured by Doppler echocardiography, between 1990 and 2000. Among patients, 154 underwent isolated CABG (group A) and 46 CABG + aortic valve replacement (AVR) (group B).

**Results:** Mortality was 2.6% (n = 4) in group A and 6.5% (n = 3) in group B (p = NS). The median AS gradients were 34 and 40 mmHg, respectively. Thirty patients (20%) in group A were in NYHA class III-IV compared to 20 (44%) in group B (p = 0.002). There was

no significant difference in postoperative complications. The mean intensive care unit stay was 2.3 and 2.2 days, respectively (p = NS); median postoperative stay was 6 and 8 days, respectively (p = 0.02). During the median follow up period of 4.2 years no patient in group A required AVR. Nine late deaths occurred in group B, none of which was cardiac-related.

**Conclusion:** Morbidity and mortality in patients who underwent combined surgery was comparable with that in patients who had isolated CABG. However, none of the patients who underwent only CABG required AVR during the follow up period. It is concluded that patients with mild AS at the time of CABG should not undergo AVR. It is possible that a cut-off AS gradient >40 mmHg should be considered for combined surgery.

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With the increase in the aging population, more patients with coronary artery disease (CAD) present with concomitant mild to moderate aortic stenosis (AS). The optimal management of patients with CAD who require coronary artery bypass graft (CABG) surgery and have coexisting asymptomatic mild to moderate AS, remains controversial (1,2). The similarity between symptoms of CAD and those of AS adds to the confusion.

Some authors recommend that AVR be performed at the time of myocardial revascularization, as studies of the natural history of mild AS have shown that the condition may progress to a critical stage within five years (3). Furthermore, the risk of reoperation for AVR in older patients who have undergone CABG with

patent grafts - often arterial - is higher (4). On the other hand, prophylactic AVR increases the operative mortality and the risk of subsequent valve-related complications.

With these concerns in mind, the present authors' experience of the management of patients undergoing CABG with mild to moderate AS was reviewed.

## Clinical material and methods

### Patients

A retrospective analysis was carried out of patients with CAD requiring CABG and with a peak AS gradient  $\leq$ 40 mmHg between January 1990 and January 2000. The patients were identified by matching the CAD and echocardiographic databases. The Department of Cardiology and Cardiac Surgery at St. George's Hospital and Medical School maintains a large database of all patients. During the study period, totals of 8,202 patients with CAD referred for surgery and 23,985 patients with CAD who underwent echocardiography were identified. Among 200

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patients thus selected, 154 underwent CABG (group A) and 46 CABG plus AVR (group B).

### Data acquisition

The following data were collected: age, sex, body surface area, history of smoking, diabetes, renal impairment, hypertension, NYHA functional class, history of myocardial infarction, prior cardiac surgery, urgency of operation (defined as having surgery following acute admission during the same hospital stay), and angina (graded using the Canadian Cardiovascular Society classification).

Echocardiography findings recorded included: AS gradient (calculated by the modified Bernoulli equation), orifice area (calculated by using valve planimetry and the continuity equation) and left ventricular function. Many of the patients predated the routine measurement of aortic valve area. Cardiac catheterization data included the number of diseased vessels and an estimation of left ventricular ejection fraction (LVEF).

Operative data included cardiopulmonary bypass (CPB) and cross-clamp times.

Postoperative complications recorded included low cardiac output (identified by a need for intravenous inotropic drugs for more than 24 h postoperatively and/or the use of intra-aortic balloon pump), reoperation for bleeding, renal failure requiring hemofiltration or dialysis, respiratory insufficiency (need for re-intubation or mechanical ventilatory support for more than 48 h), the presence of severe wound infection/dehiscence and cerebrovascular accident. An overall morbidity score was calculated taking these

complications into account. Cardiac death during follow up was defined as death due to myocardial infarction, cardiac arrest, fatal ventricular arrhythmias, or sudden unexplained death. Operative mortality was defined as any death during hospitalization or within 30 days of surgery.

### Statistical analysis

All patient characteristics were expressed as mean values. Univariate analyses were performed with each categorical or dichotomous variable, and data distribution for continuous variables. The differences were defined by chi-square and Mann-Whitney tests, respectively.

### Results

Both patient groups were similar with respect to the preoperative risk factors, except for the presence of hypertension being more common in group A. Patients in group A were also in a more advanced stage of angina, whereas those in group B were in a higher NYHA class (Table I). The extent of CAD and frequency of preoperative myocardial infarction were similar in both groups.

More patients in group B had a low LVEF (<30%) and higher AS gradients compared with patients in group A (Table I).

The mean cross-clamp and CPB times were  $37.0 \pm 15.9$  and  $82.0 \pm 32.0$  min, and  $79.0 \pm 25.9$  and  $131.0 \pm 42.3$  min in groups A and B, respectively ( $p = 0.01$ ).

There were no significant inter-group differences in postoperative complications (Table II). Four (2.6%)

*Table I: Patient characteristics.*

Variable	Group A (n = 154)	Group B (n = 46)	p-value
Age (years)*	67 ± 8.7	68 ± 10.5	NS
Gender ratio (M:F)	111:43	39:7	NS
BMI*	27 ± 4.1	26 ± 4.8	NS
Hypertension	92 (59.7)	15 (32.6)	0.001
Diabetes	31 (20.1)	10 (21.7)	NS
Smoking	71 (44.8)	23 (50)	NS
NYHA class III-IV	30 (19.5)	20 (43.5)	0.002
Angina class 3-4	111 (72.1)	19 (41.3)	0.00003
Parsonnet score	8 (6.5)	18 (9.5)	0.00
MI	22 (14.3)	4 (8.7)	NS
Renal impairment	1	0	NS
Diseased vessels	2.6	2.5	NS
Urgent surgery	60 (38.9)	19 (41.4)	NS
LVEF <30%	10 (6.5)	9 (19.6)	0.04

\*Values are mean ± SD.

Values in parentheses are percentages.

BMI: Body mass index; LVEF: Left ventricular ejection fraction; MI: Myocardial infarction; NS: Not significant.

Table II: Morbidity and mortality.

Variable	Group A (n = 154)	Group B (n = 46)	p-value
Peroperative death (n)	4 (2.6)	3 (6.5)	0.2
Morbidity (n)	28 (18.2)	12 (26.1)	0.2
ICU stay (days)*	2.3 ± 4.4	2.2 ± 4.4	0.8

\*Values are mean ± SD.

Values in parentheses are percentages.

patients died in group A, compared with three (6.5%) in group B (p = NS). All deaths were attributed to low cardiac output and multi-organ failure. Follow up data were available for a total of 188 patients (94%). During the mean follow up period of 4.2 years (range: 6 months to 9 years), there were two deaths in group A and nine late deaths in group B, but all were non-cardiac-related. None of the patients in group A has undergone redo surgery for AVR with or without repeat CABG. Similarly, none of the patients in group B has required redo surgery.

## Discussion

Controversy persists with regard to performing concomitant AVR in patients undergoing CABG with mild to moderate AS (1,2). A 'prophylactic' AVR obviates the need for a future redo surgery in patients who may be of an advanced age with patent grafts, including a mammary graft. However, this must be balanced against the risk of a combined CABG and AVR and subsequent valve-related complications. One factor that must be considered when making this decision is the progression of mild to moderate AS.

The progressive nature of AS is well recognized (5,6). Progression has been assessed by changes in aortic valve area and pressure gradients. Studies have shown that, on average, the aortic valve area decreases by approximately 0.1-0.3 cm<sup>2</sup> per year (7,8), while the pressure gradient increases by up to 10-15 mmHg per year (3,9). The progression of stenosis is multifactorial, and may be related to valve anatomy, leaflet calcification, or the presence of CAD. There is considerable variability in the rate of progression from patient to patient. For example, those with mild AS generally have a slower rate of progression compared to patients with more severe disease. Likewise, progression is more rapid in congenital bicuspid valves and slowest for rheumatic valves (6,10). It is important to consider the size of the patient when surgical criteria are based on aortic valve area; that is, an aortic valve area of 1.0-1.5 cm<sup>2</sup> is generally considered as moderate AS, yet the same situation in a small patient may represent mild AS (1).

Some groups have reported high mortality (19%) following AVR after previous CABG (4) in patients who had mild to moderate AS at the time of CABG. In contrast, others have reported a similar risk to that for primary AVR and CABG (11). In the latter study, the authors reported on 427 patients who underwent AVR+CABG and 52 who underwent AVR with or without CABG after prior CABG with mortalities of 6.3% and 7.4% respectively, and similar morbidity. Some of the technical difficulties in the redo situation are attributed to the handling of patent grafts (especially the internal thoracic artery) and providing satisfactory myocardial protection with patent in-situ arterial grafts.

Others have reported a higher mortality with subsequent AVR. Fighali et al. (12) and Odell et al. (13) have shown a higher operative mortality of 14% and 17% respectively for subsequent AVR. Others - for example Sundt and colleagues (11) - have shown a higher mortality for AVR subsequent to CABG, but these differences did not reach statistical significance. Similarly, Fiore et al. (14) reported an operative mortality of 9% in 175 patients following CABG+AVR, while Hoff et al. (15) reported 23 patients who underwent AVR subsequent to CABG at an average of 7.6 years following the first operation, with no perioperative deaths. In a more recent study, Hochrein and colleagues (16) advocated AVR at the time of CABG for patients with asymptomatic AS or aortic incompetence. These authors based their conclusion on a similar 30-day mortality rate (11.2% in the AVR+CABG group, n = 44; versus 9.8% in the CABG group, n = 62) and a high estimated need for aortic valve reoperation in the CABG group (24.3%) compared with 3% in the AVR+CABG group in those followed up for six years. However, freedom from aortic valve reoperation was 85.5% in the CABG and 93.5% in the AVR+CABG group, with mean times of 62.4 and 97.3 months, respectively. In all of the above studies the average time from the initial CABG to subsequent AVR ± CABG was approximately eight years. Approximately 50% of patients in these studies underwent redo CABG at the time of the second operation. Therefore, it is possible that they required a second

operation for graft occlusion, and not necessarily for significant AS. The median follow up in the present study was 4.2 years. As the above studies have shown, the need for redo surgery occurs at approximately five to seven years. Therefore, it is possible that a longer follow up is required in order to assess accurately the need for redo surgery.

Despite some of these latter studies showing similar results for CABG and AVR ± CABG, and the safety of a redo operation, there are disadvantages in performing combined AVR+CABG as opposed to isolated CABG. These include a higher early and late mortality and morbidity, including surgery for prosthetic valve malfunction (17) at approximately 2-6% per year.

Of interest, Vaturi et al. (18) evaluated the long-term course of aortic valve disease and the need for AVR in patients with rheumatic mitral valve disease who underwent mitral valve surgery. A total of 131 patients was followed up after mitral valve surgery for a mean period of 123 patient-years. At the time of surgery, 45% of patients had mild aortic valve disease (5% stenosis, 44% insufficiency), and this had increased to 75% at the end of follow up. In only six patients (5%) among the entire cohort was AVR needed after a mean period of 21 years, and in four cases the primary indication was prosthetic mitral valve dysfunction. These authors concluded that mild aortic valve disease at the time of mitral valve surgery does not progress to severe disease.

Some investigators have proposed aortic valve repair at the time of myocardial revascularization, thus delaying reoperation for AVR. Decalcification of the valve has been suggested, with good short-term results. However, the long-term outcome has been disappointing due to scarring of the leaflets of the aortic valve with resultant restenosis or regurgitation within one to five years (19,20).

In the present study it was shown that there is no significant difference in morbidity and mortality between those patients who underwent CABG alone and those who underwent CABG and AVR. None of the patients with mild AS who underwent CABG alone required reoperation for AVR during the (relatively short) follow up period, and this reinforces the hypothesis that mild AS progresses only slowly. It must be noted however that in the CABG group the median peak AS gradient was 34 mmHg, whereas in the AVR+CABG group this was 40 mmHg. It is concluded that patients with mild AS at the time of CABG should not undergo AVR. It is possible that a higher cut-off AS gradient >40 mmHg should be considered for a combined operation.

### Study limitations

The end point of the present study was considered to

be the need for redo surgery, and especially the need for AVR in patients with primary CABG. The majority of patients were followed up in their local hospital; hence follow up echocardiography was performed by different operators, and the decision to refer for redo surgery made by different cardiologists. However, an annual or bi-annual report has been sent to the tertiary center. Although documentation of the valve-related complications was incomplete, the occurrence and cause of late deaths was double-checked with the National Office of Population Census and Surveys.

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### References

1. Rahimtoola SH. Should patients with asymptomatic mild to moderate aortic stenosis undergoing coronary artery bypass also have valve replacement for their aortic stenosis? *Heart* 2001;85:337-341
2. Rahimtoola SH. Prophylactic valve replacement for mild aortic valve disease at time of surgery for other cardiovascular disease? ... No. *J Am Coll Cardiol* 1999;33:2009-2015
3. Lester S, Heilborn B, Gin K, Dodek A, Jue J. The natural history and rate of progression of aortic stenosis. *Chest* 1998;113/4:1109-1114
4. Collins JJ, Aranki SF. Management of mild aortic stenosis during coronary artery bypass graft surgery. *J Cardiovasc Surg* 1994;9(Suppl.):145-147
5. Horstkotte D, Loogen F. The natural history of aortic valve stenosis. *Eur Heart J* 1988;9(Suppl.):57-64
6. Davies SW, Gershliak AH, Balcon R. Progression of valvar aortic stenosis: A long-term retrospective study. *Eur Heart J* 1991;12:10-14
7. Brener SJ, Duffy CI, Thomas JD, Stewart WJ. Progression of aortic stenosis in 394 patients: Relation to changes in myocardial and mitral valve dysfunction. *J Am Coll Cardiol* 1995;25:305-310
8. Otto CM, Burwash IG, Legget ME, et al. Prospective study of asymptomatic valvular aortic stenosis: clinical, echocardiographic, and exercise predictors of outcome. *Circulation* 1997;95:2262-2270
9. Otto CM, Pearlman AS, Gardner CL. Hemodynamic progression of aortic stenosis in adults assessed by Doppler echocardiography. *J Am Coll Cardiol* 1989;13:545-550
10. Wagner S, Selzer A. Patterns of progression of aortic stenosis: A longitudinal hemodynamic study. *Circulation* 1982;65:709-712
11. Sundt TM, Murphy SF, Barizilai B, et al. Previous coronary artery bypass grafting is not a risk factor

- for aortic valve replacement. *Ann Thorac Surg* 1997;64:651-658
12. Fighali SF, Avendafio A, Elayda MA, et al. Early and late mortality of patients undergoing aortic valve replacement after previous coronary artery bypass graft surgery. *Circulation* 1995;92(Suppl.II):II163-II168
  13. Odell JA, Mullany CJ, Schaff HV, et al. Aortic valve replacement after previous coronary artery bypass grafting. *Ann Thorac Surg* 1996;62:1424-1430
  14. Fiore AC, Swartz MT, Naunheim KS, et al. Management of asymptomatic mild aortic stenosis during coronary artery operations. *Ann Thorac Surg* 1996;61:1693-1698
  15. Hoff SJ, Merrill WH, Stewart JR, Bender HW, Jr. Safety of remote aortic valve replacement after prior coronary artery bypass grafting. *Ann Thorac Surg* 1996;61:1689-1692
  16. Hochrein J, Lucke JC, Harrison K, et al. Mortality and need for reoperation in patients with mild-to-moderate asymptomatic aortic valve disease undergoing coronary artery bypass graft alone. *Am Heart J* 1999;138:791-797
  17. Hammermeister KE, Sethi GK, Henderson WG, Oprian C, Kim T, Rahimtoola SH. A comparison of outcomes in men 11 years after heart-valve replacement with a mechanical valve or bioprosthesis. *N Engl J Med* 1993;328:1289-1296
  18. Vaturi M, Porter A, Adler Y, et al. The natural history of aortic valve disease after mitral valve surgery. *J Am Coll Cardiol* 1999;33:2003-2008
  19. Shapira N, Lemole GM, Fernandez J, et al. Aortic valve repair for aortic stenosis in adults. *Ann Thorac Surg* 1990;50:110-120
  20. Freeman WK, Schaff HV, Orszulak TA, Tajik AJ. Ultrasonic aortic valve decalcification: Serial Doppler echocardiographic follow up. *J Am Coll Cardiol* 1990;16:623-630